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# INDO-PACIFIC MOLLUSCA

*Monographs of the Marine Mollusks of the  
Tropical Western Pacific and Indian Oceans*

EDITED BY

**R. TUCKER ABBOTT**

**VOLUME 2**

*Published by*

**THE DEPARTMENT OF MOLLUSKS**  
Academy of Natural Sciences of Philadelphia  
Philadelphia, Pennsylvania, 19103  
U.S.A.

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*[this sheet issued August 30, 1968, with vol. 2, no. 9]*



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Tropical Western Pacific and Indian Oceans*

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*Publication commenced*  
*March 31, 1959*  
*Volume 2 commenced*  
*August 30, 1968*

INDO-PACIFIC MOLLUSCA is a professional journal devoted to the systematics and taxonomy of the marine mollusks, both living and fossil, of the world, but with emphasis on those of the tropical Western Pacific and Indian Oceans.

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perryi Iredale, 201	12-715	pyramidata Cuvillier, 40	12-454
persimilis "Kuroda", 129	12-605	pyrum Lamarck, 166	12-664
petersoni Conrad, 41	12-455		
petrosa Conrad, 1855, 110	12-572		
petrosum Conrad, 1849, 121	12-589		
pfeifferi Crosse, 128	12-604	quadratum Link, 196	12-710
pfeifferi Hidalgo, 128	12-604	quadricincta "Bonelli", 96	12-556
Phalium Link, 79	12-529	quatuorcineta "Bell. & Micht.", 96	12-556
phillipsi d'Archiac & Haime, 39	12-453	quenstedti Beyrich, 123	12-595
pila Reeve, 128	12-604	quilonensis Dey, 131	12-607
pilsbryi Woodring & Olsson, 101	12-561	quinquecineta "Bell. & Micht.", 96	12-556
pirum Lam., von Martens, 187	12-689	quineseriata Sacco, 56	12-478
platystoma "Bruguère", 152	12-630		
platystoma Gignoux, 152	12-630		
plicaria Lamarck, 94	12-548		
plicata Defrance, 74	12-516	raristriata Sacco, 152	12-630
plicata G. Fischer, 39	12-453	rarituberculata Sacco, 74	12-516
plicata Meuschen, 33	12-447	reclusum Guppy, 163	12-657
plicata Scopoli, 102, 156	12-652	recurvirostrum Gmelin, 158	12-652
plicatum Gmelin, 73	12-515	rembangensis K. Martin, 130	12-606
plicatum Linné, 39	12-453	reticulata "Bonelli", 153	12-631
94	12-548	reticulosa Sacco, 74	12-516
plioasulcata Sacco, 152	12-630	retifera Noszky, 97	12-557
pliolonga Sacco, 152	12-630	retusa Deshayes, 57	12-479
pliocrassa Sacco, 152	12-630	retusa Michelotti, 56	12-478
pliodentata Sacco, 152	12-630	retusa Newton, 34	12-448
pliodepressa Sacco, 152	12-630	rex Tegland, 121	12-589
plioelegans Sacco, 96	12-556	ringens Swainson, 40	12-454
pliogigantea Sacco, 152	12-630	rondeleti Basterot, 97	12-557
pligloboides Sacco, 152	12-630	rotunda Sacco, 152	12-630
plioinflata Sacco, 152	12-630	rotundata Defrance, 40	12-454
pliomalleata Sacco, 152	12-630	95	12-555
priorondoletii Sacco, 96	12-556	rotundata Perry, 52	12-474
pliosulcatissima Sacco, 152	12-630	rotundo-varicosa Sacco, 152	12-630
pluriplicata Sacco, 152	12-630	royanum Iredale, 173	12-671
pollens Finlay, 115	12-579	rufa Linné, 69	12-509
pollicaris Meuschen, 33	12-447	rufescens Röding, 70	12-510
pomum Schubert & Wagner, 152	12-630	rugosa Röding (in part), 91	12-545
ponderosa Gmelin, 195	12-709	rugosa Röding (in part), 93	12-547
porcatum Pulteney, 35	12-449	rugosum Gmelin, 91	12-545
postmamillaris Sacco, 56	12-478	rugulosa Sacco, 153	12-631
powelli Finlay, 172	12-670	rumpffii Gmelin, 53	12-475
preangerensis K. Martin, 49	12-471	ruscinensis Fontannes, 74	12-516
protesticulus Sacco, 74	12-516		
protojaponica Noetling, 40	12-454		
pseudocrumena Sacco, 74	12-516		
pulchella Jeffreys, 40	12-454	saburon Bruguère, 151	12-629
pullum Born, 69	12-509	saburoni Locard, 152	12-630
pullus Röding, 40	12-454	sacci [sic] Rovereto, 57	12-479
punctata G. Fischer, 40	12-454	saccoi Noszky, 37	12-451
pusio Bayer, 160	12-654	saccoi Rovereto, 57	12-479
pustulata Cox, 71	12-513	sacconi Noszky, 37	12-451
pygmaea Muenster, 40	12-454	sacyi Cossmann & Peyrot, 153	12-631

	[looseleaf]		[looseleaf]
salisburyensis Ludbrook, 64	12-496	subtriseriata Sacco, 96	12-556
sandbergeri Speyer, 97	12-557	subtuberosa Hanna, 51	12-473
saussurea Risso, 40	12-454	suburnon Reeve, 129	12-605
savonensis Sacco, 74	12-516	subvariabilis Sacco, 96	12-556
scabrida Fuchs, 98	12-558	subventricosa Speyer, 97	12-557
scrobiculata Menke, 128	12-604	sufflatum Tenison-Woods, 138	12-614
sculptum J. de C. Sowerby, 139	12-615	sulcata Meuschen, 33	12-447
Semicassis Mörch, 125	12-601	sulcata Risso, 42	12-456
semielegans Rovereto, 40	12-454	sulcatum Link, 87	12-541
semigranosum Lamarck, 145	12-621	sulcifera Sowerby, 53	12-475
senegalica Gmelin, 72	12-514	sulcosa Buguière, 159	12-653
senni Rutsch, 163	12-657	sulcosum Born, 159	12-653
sepa "Röding" Clench, 158	12-652		
Schichiheia Hatai & Nisiyama, 95	12-555		
shubutensis Aldrich, 41	12-455	taitii Conrad, 109	12-571
sinuosum Verco, 148	12-624	taurinensis Sacco, 56	12-478
skinneri Marwick, 136	12-612	97	12-557
soldadensis Maury, 41	12-455	152	12-630
sophia Brazier, 131	12-607	tenuilabris Menke, 197	12-711
sophiae Brazier, 132	12-608	tenuis Gray, 75	12-517
sowerbii Lea, 124	12-596	tenuis Hirase, 145	12-621
spectabile Iredale, 170	12-668	tenuis Wood, 75	12-517
spinella Clench, 52	12-474	tessellata Gmelin, 53	12-475
spinosa Newton, 34	12-448	tessellata Pfeiffer, 158	12-652
spinosum Gronovius, 54	12-476	tessellata Wrigley, 34	12-448
spirata Meuschen, 33	12-447	tessellatum Wood, 128	12-604
stadiale Hedley, 169	12-667	testiculoides Sacco, 74	12-516
stazzanensis Sacco, 96	12-556	testiculus Linné, 71	12-513
striata Defrance, 154	12-632	textilis Tate, 66	12-498
striata Meuschen, 33	12-447	thaesei Brongniart, 57	12-479
striata J. de C. Sowerby, 123	12-595	thesei Brongniart, 57	12-479
striatella Grateloup, 153	12-631	thomsoni Brazier, 178	12-676
striatula Bell. & Micht., 123	12-595	togata Whitc, 41	12-455
striatula "Bonelli", 123	12-595	tongriana Sacco, 42	12-456
striatum Gmelin, 50	12-472	toreuma Powell, 114	12-576
striatus Hutton, 136	12-612	torquata Reeve, 197	12-711
strigatum Gmelin, 89	12-543	torva Iredale, 66	12-498
striolata Risso, 41	12-455	Trachydolium Howe, 95	12-555
subareola Orbigny, 154	12-632	transenna Tate, 138	12-614
subcrumena Orbigny, 75	12-517	transiens Sacco, 96	12-556
subenodis Newton, 34	12-448	152	12-630
subenodis Wrigley, 34	12-448	triangularis Coulon, 50	12-472
subflammea Orbigny, 56	12-478	tricarinata Schafhäutl, 39	12-453
subgranosa Tate, 41	12-455	tricincta Sacco, 96	12-556
subgranulosa Orbigny, 153	12-631	tricinta [sic] "Bell. & Micht.", 96	12-556
subharpaeformis d'Archiac & Haime, 41	12-455	trifasciatum Gmelin, 159	12-653
subharpaeformis Sacco, 57	12-479	trinodosum Tate, 116	12-580
subintermedia Orbigny, 41	12-455	triquetra Rigacci, 50	12-472
sublaevigaster d'Archiac & Haime, 42	12-456	trituberculatum Weaver, 109	12-571
subottnangiensis Sacco, 123	12-595	trituberculoides Kanno, 42	12-456
substriata Newton, 34	12-448	tuberculata G. Fischer, 94	12-548
subsulcosa Hoernes & Auinger, 153	12-631	tuberculata Gabb, 59	12-487
subtesticulus Orbigny, 74	12-516		

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## THE HELMET SHELLS OF THE WORLD (CASSIDAE). PART 1.

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Academy of Natural Sciences of Philadelphia

The family Cassidae is a world-wide tropical and temperate seas group of caenogastropods, popularly known as helmet or bonnet shells, which is closely related to the families Bursidae, Cymatiidae and Tonnidae. It is placed by Thiele

(1929) and Wenz (1941) in the superfamily Tonnacea. The family originated in the Lower Eocene, and by the Miocene had become established throughout the warm and temperate seas of the world. Today there are about 60 living species, most of which occur in waters from the low tide mark to a depth of about 100 meters. The deepest record is 1,100 meters off East Africa.



Plate 1. Female *Phalium* (*Semicassis*) *granulatum* (Born, 1778) of Florida in the process of building a tower-shaped egg mass. Each brown, horny capsule is extruded from a pore

in the sole of the foot and put in place by the edge of the foot. Each capsule contains several dozen eggs. Photographed at the Marine Studios, Marineland, St. Augustine, Florida.

In part 1, the genera treated are *Cassis*, *Phalium*, *Casmaria*, and *Cypraecassis*. Part 2 will include *Sconsia*, *Dalium*, *Morum*, *Galeodea*, *Morionella* and *Taieria*. About 1,100 specific and varietal names have been applied to Recent and fossil cassids.

Adult cassid shells range in size from 1 to 15 inches and are usually characterized by an ovate shape, a large body whorl, one or more varices, a well-developed parietal or columellar shield, and by a small, bulimoid, shelly nucleus. The operculum, present in most adults, is corneous, thin, semi-circular or fan-shaped, and brown. The radula is taenioglossate, with about 80 to 220 rows of teeth, with each row bearing seven rather delicate, minutely-cusped teeth. The pleurembolic proboscis is retracted within the head when not in use. The eyes are at the base of the moderately long, thin tentacles. Males have a long, prong-like penis attached to the right side of the head. The sperm travels to the top of the penis along an open groove. Females (in *Phalium*) lay eggs within small capsules which are built into tower-like structures. The capsules are formed by a round sphincter in the sole of the foot. *Galeodea*, from the Mediterranean, lays 300 eggs in each capsule, but only 4 to 12 develop fully, the remainder serving as food or "nurse cells" for the others (Erlanger, 1893).

The length of the free-swimming larval stage is unknown, but the presence of four or five whorls in the nucleus suggests that it may be up to several weeks.

A slight degree of sexual dimorphism in the shell is evident in *Cassis cornuta* (Linné), males having fewer and longer knobs on the shoulder.

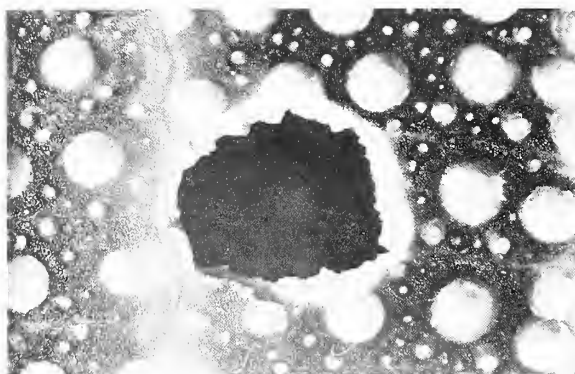


Plate 2. Hole (5.5 mm. in diameter) in the denuded test of the sea urchin, *Lytechinus variegatus* (Lamarck) made by *Cassis tuberosa* (Linné) in an aquarium in the Bahamas. (courtesy of Robert Robertson).

Males of *Phalium* usually are much smaller than the females.

The food of *Cassis* and *Phalium* consists of various echinoderms such as sea urchins, sand dollars and sea biscuits belonging to the class Echinoidea (R. E. Schroeder, 1962; R. W. Foster, 1947; F. B. Lyman, 1937; D. R. Moore, 1956; and I. Cornman, 1963). In attacking a long-spined sea urchin, such as *Diadema antillarum*, a *Cassis* everts its proboscis and waves the tip over the surface of the urchin's test, at the same time squirting out an acidic salivary fluid which immobilizes the spines. The active principle of the saliva would appear to be a neurotoxin with paralyzing properties (I. Cornman, 1963). Cassids may crush or bore through the test of the urchin.

*Cassis madagascariensis* and *tuberosa* of the Caribbean region feed upon the long-spined sea-urchin, *Diadema antillarum* Philippi. According to Schroeder (1962, Sea Frontiers, vol. 8, no. 3, pp. 156-160), when these gastropods encounter an urchin on which they wish to feed, they elevate the foot anteriorly, creep forward, and fall upon the prey, pinning it beneath. Within about 10 minutes the proboscis rasps a hole in the test of the urchin about 6 to 10 mm. in diameter for feeding. The helmet shells may remain on top of the urchin for an hour or more. Surprisingly, the spines rarely penetrate the foot of the snail.

The geographical distribution of *Cassis tuberosa* (Linné) overlaps that of the sea urchin, *Lytechinus variegatus* (Lamarck), upon which it feeds (Bermuda and North Carolina, south through the Caribbean to Brazil). *Cassis madagascariensis* Lamarck and one of its foods, *Diadema antillarum*, have a common but more restricted range (Bermuda and North Carolina to the southern Caribbean).

Dr. Robert Robertson has kindly allowed me to quote from his unpublished notes the following remarks on the behavior of *Cassis* in the Bahamas.

"Species of *Cassis* are usually rather deeply buried in sand at Bimini so that occasionally only a small portion of a shell projects. Sometimes *Cassis* occurs in *Thalassia* beds. All species in the genus *Cassis* probably feed exclusively on echinoids. The thick skin on the foot is an adaptation which facilitates capture without injury from the spines. *C. tuberosa* and *C. madagascariensis* are most frequently found eating the sea biscuit *Clypeaster rosaceus*, show-



ing preference for small individuals. All three species of *Cassia* will, however, readily also attack sea urchins in a large aquarium but at night only. While feeding, the foot of the *Cassia* partially surrounds the echinoid (which often is held deep in the sand) and copious mucus is produced. Some or all of the spines of the echinoid are removed and the proboscis of the *Cassia* is either inserted through the anus, as has been observed at Bimini by Foster (1947) in the case of a *C. tuberosa* feeding on *Clypeaster*, or through a hole which is made in the test. The test of *Clypeaster* usually breaks apart while *Cassia* feeds. *Cassia* feces consist chiefly of the spines of the echinoids which have been fed upon; the spines are enclosed in a mucous covering.

The holes through sea urchin tests made by *Cassia* at Bimini are more or less circular and from 4 to 6 mm. in diameter. There seems to be no special area on the test which is pierced. An acid appears to be used, at least in part, to make the hole, for the edge is smoothly rounded and concave all around except at each joint between plates of the test where there is either an irregular groove or a lamina."

The family has a limited economic value. For many centuries, shell cameos have been carved from Indian Ocean *Cypraea* *rufa* (Linné). During the 19th century *Cassia* *madagascariensis* Lamarck and *tuberosa* (Linné) of the West Indies were used to a lesser extent. The meat of larger species is eaten in many parts of the world. E. R. Cross (1967) gives an excellent recipe for chowder made from the minced foot and columellar muscle of *Cassia* *cornuta* (Linné).

### Distribution of Cassids

The world-wide family of Cassidae contains about 60 living species. About one fourth of these possess subspecies. In the tropical Indo-Pacific there are 20 living species and subspecies (exclusive of *Galeodea*, *Moruni* and *Sconsia*), while in the Caribbean there are only seven.

Although the cassids are predominantly a warm-water group, they have a somewhat different distribution than that of the family Strombidae, which contains about the same number of species (see Indo-Pacific Mollusca, vol. 1, no. 2, p. 09-838, pl. 19). The cassids have a wider distribution, with about ten percent of the species living in the cool waters of the

southern hemisphere and five percent living in northern temperate regions. This ability to survive colder waters is demonstrated by the bathymetric range of several cassids which may live at depths from 100 to 1,100 meters. This is in contrast to the herbivorous Strombidae which do not live below 100 meters.

The concentration of species in the center of the Indo-Pacific, along the Western Pacific Arc, is much less pronounced in the cassids, although that area has the highest number of cassid species. As would be expected, there is a gradual diminishing in the number of species towards the east where there are only a few species in Polynesia. There are no cassids endemic to the Western Pacific Arc, although *Phalium* *bandatum* and *Phalium* *decussatum* live in approximately that area.

There are several shallow-water species of cassids with rather restricted ranges—*Phalium* *umbilicatum*, from the Hawaiian Chain; *Phalium* *strigatum*, from China, Korea and Japan; *Phalium* *bandatum* subspecies *exaratum*, from the Mauritius-Seychelles area; and *Phalium* *faurotis*, from the western edges of the Indian Ocean. The distribution of the latter is similar to that of *Strombus* *fusiformis*.

Six cassid species are widely distributed over most of the Indo-Pacific, from the Red Sea to Polynesia. In size of adults, these range from the small, inch-long *Casuarina* *pouderosa* to the large, foot-long *Cassia* *cornuta*. There was no correlation between the size of the nuclear whorls, which is sometimes indicative of the length of the free-swimming larval stage, and the extent of the geographical distribution.

The relative abundance of individuals over the entire range of the species may vary considerably. This is not always because of the lack of or presence of suitable habitats. It may be a case of the species dying out for any one of a number of biological reasons, or that it is a new arrival to the area. One notable case is *Cypraea* *rufa*, a large, conspicuous, shallow-water species. In central East Africa it is so abundant that it is fished commercially in large numbers. In the central Indian Ocean it is moderately common. However, farther to the east, in the Philippines and East Indies, it is fairly rare, and only isolated, small colonies are encountered in Melanesia. Its occurrence is very sparse in Micronesia. In the Line Islands and other easterly Polynesian archipelagos, the species becomes increasingly abundant. Pos-

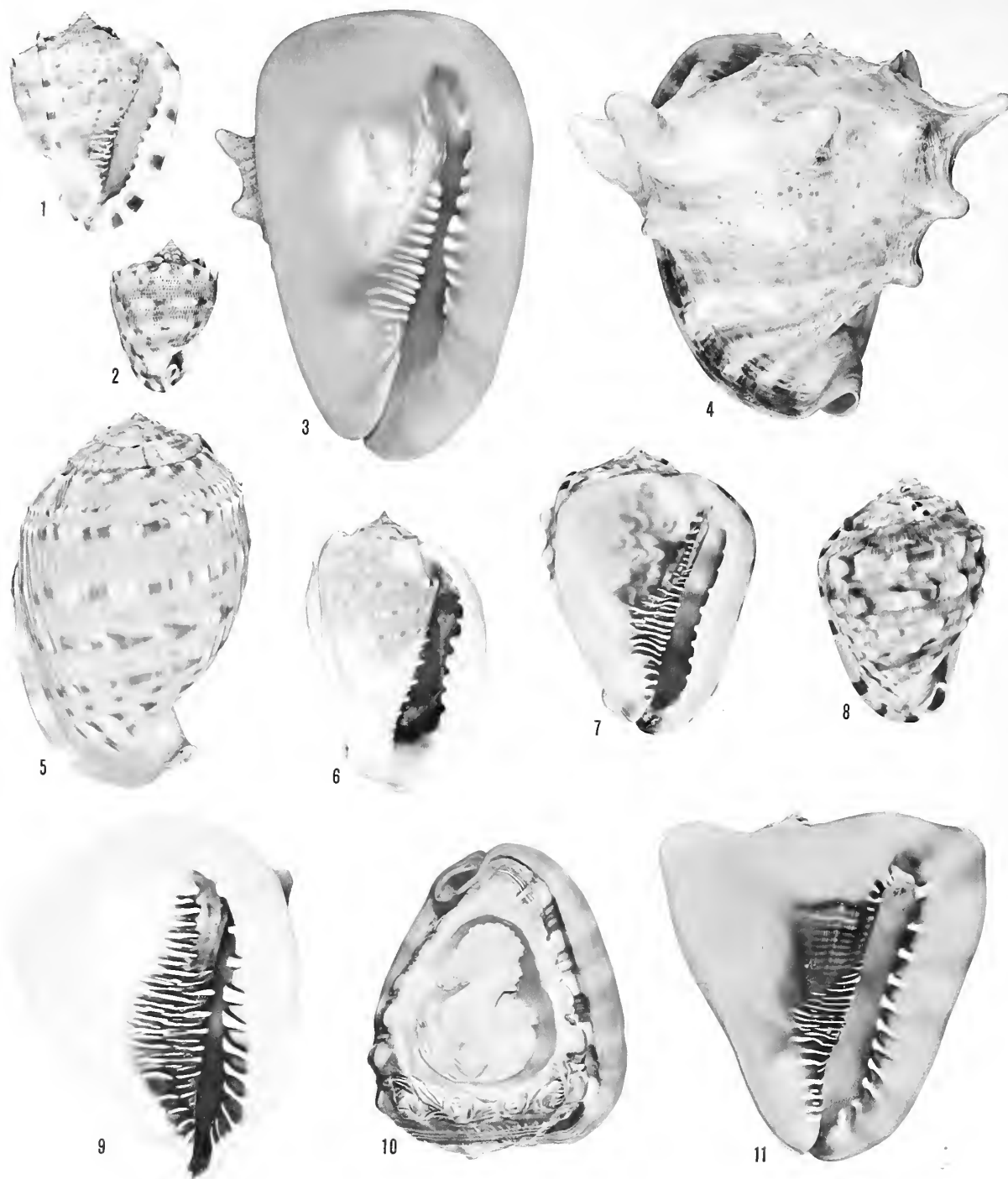


Plate 3

- Figs. 1-4. *Cassis cornuta* (Linné, 1758). 1 and 2, young from Cebu Id., Philippines; 3, adult from Luzon Id., Philippines; 4, adult male from Babelthnap, Palau Ids.
- 5,6. *Cassis tessellata* (Gmelin, 1791). Gaboon, West Africa.

- 7,8. *Cassis flammea* (Linné, 1758). Bahama Islands.
9. *Cassis madagascariensis* Lamarek, 1822. New Providence Id., Bahamas.
10. Cameo carved in Italy from *Cypraeacassis rufa* (Linné, 1758) from East Africa.
11. *Cassis tuberosa* (Linné, 1758). Cabo Rojo, Puerto Rico.

(all 1/3 natural size; shell in fig. 3 is 7 inches in length)



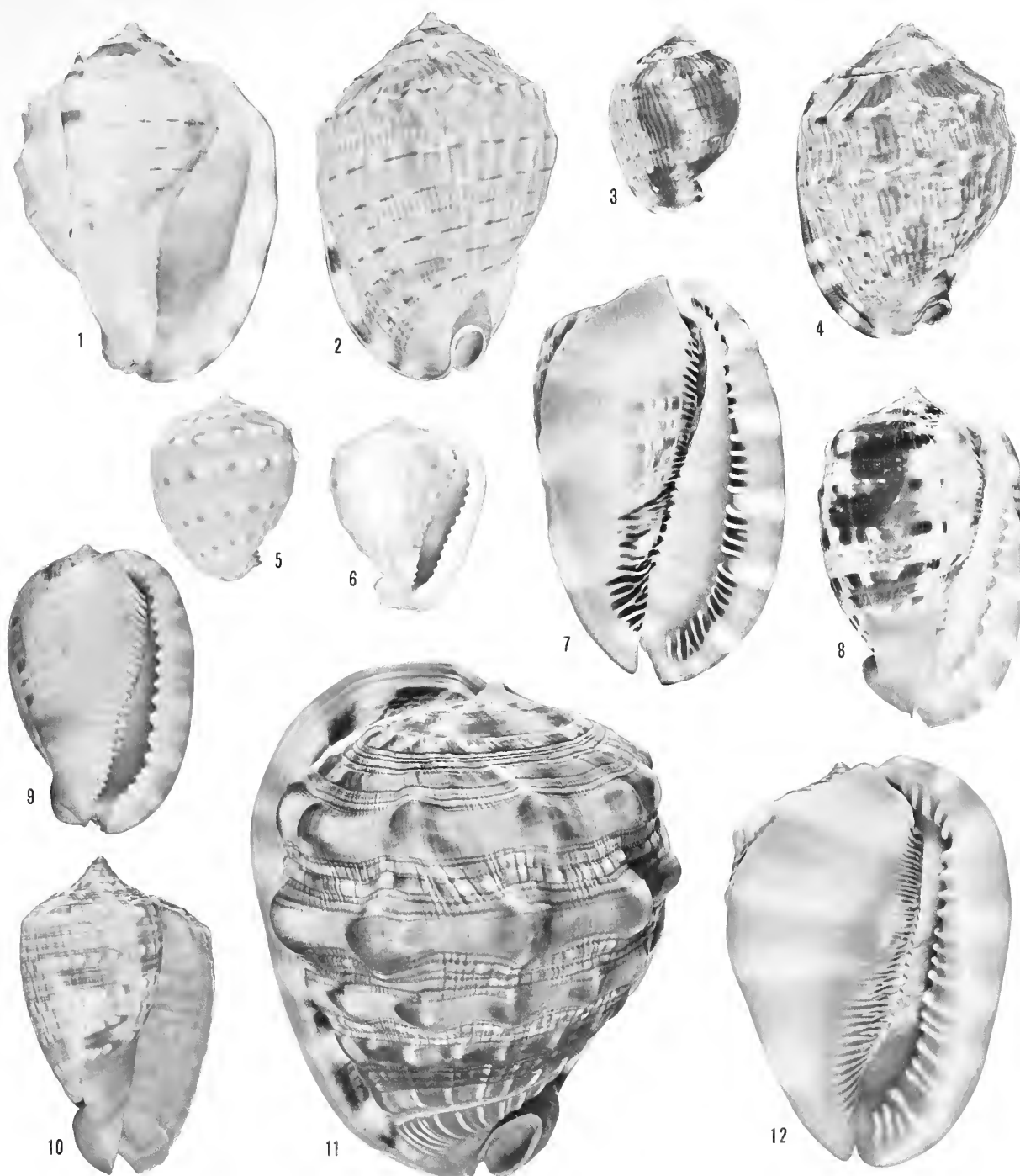


Plate 4

- Figs. 1-4. *Cassis fimbriata* Quoy and Gaimard, 1833. 1, Eucla, Western Australia. 2, form resembling type of *bicarinata* Jonas, South Australia. 3 and 4, young and adult from Gulf of St. Vincent, South Australia. 5, 6. *Cassis nana* Tenison-Woods, 1879. Adults from off Tin Can Bay, Queensland, Australia. 7. *Cypraccassis tenuis* (Wood, 1828). Gulf of California.

8. *Cypraccassis coarctata* (Sowerby, 1825). Pedro Gonzales, Perlas Ids., Panama. 9. *Cypraccassis testiculus* (Linné, 1758). Dominica, Lesser Antilles. 10-12. *Cypraccassis rufa* (Linné, 1758). 10, immature, Mkunduchi, Zanzibar. 11, adult, Mozambique City. 12, dwarf adult, Peros Banhos Id., Chagos Islands.

(all 1/2 natural size)

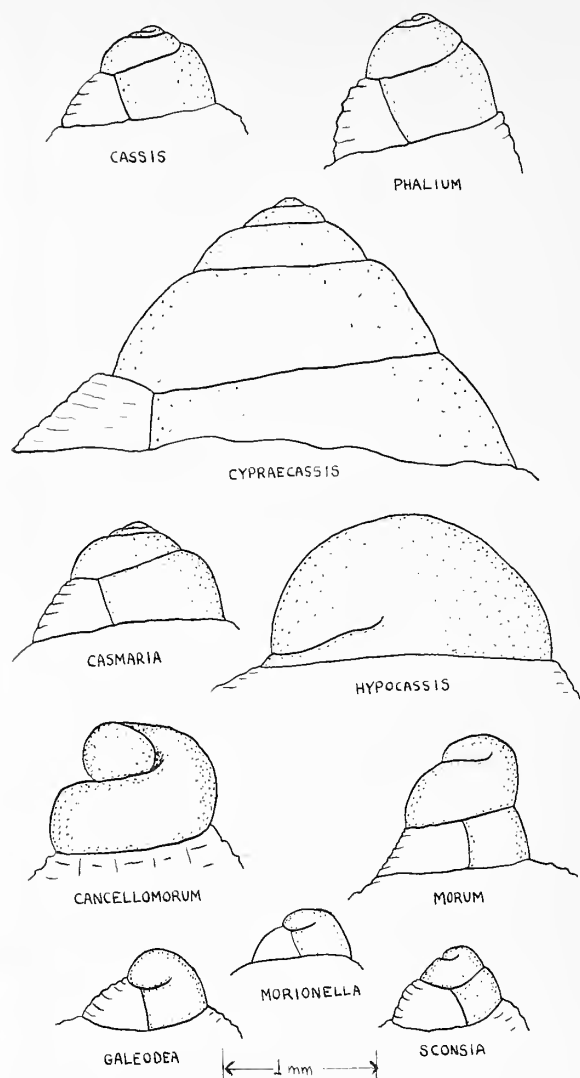
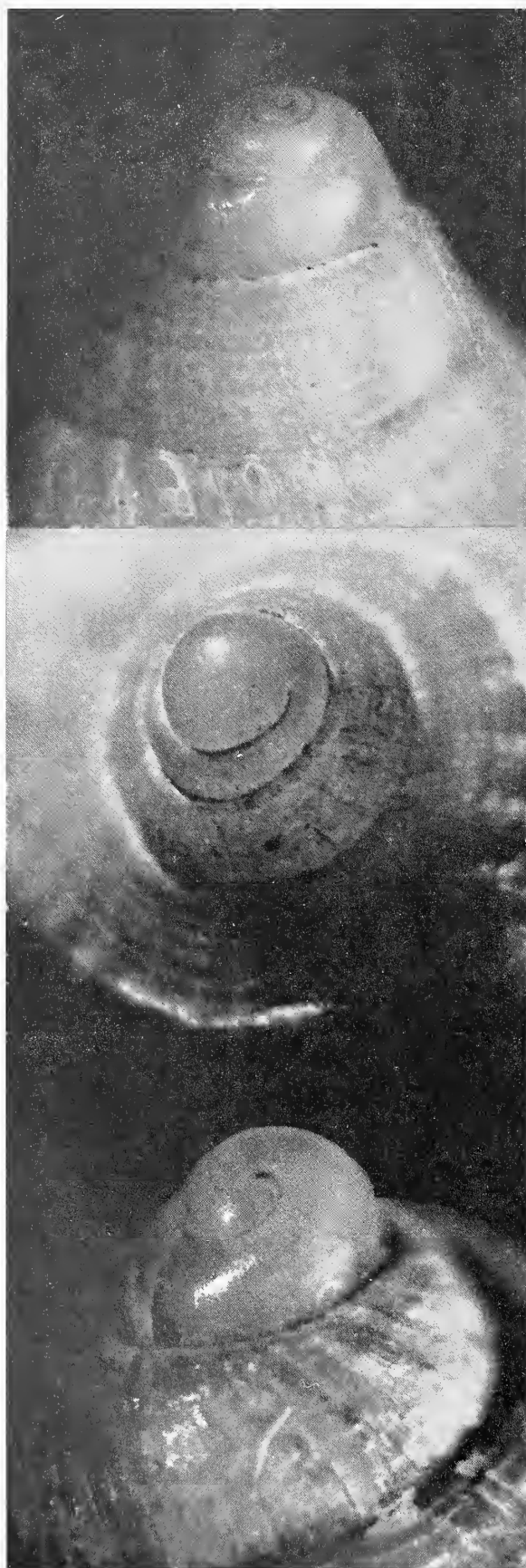


Plate 6. Nuclear whorls of various genera of Cassidae. All enlarged proportionately. Examples are from *Cassis cornuta* (Linné) from Hawaii; *Phalium glaucum* (Linné) from Phuket, Thailand; *Cypraeassis rufa* (Linné) from Zanzibar; *Cassmaria erinaceus* (Linné) from Samar Island, Philippines; *Cassis (Hypocassis) fimbriata* Quoy and Gaimard from South Australia; *Cancelloporum* (Emerson and Old, 1963) *cancellatum* (Sowerby) from Japan; *Morum oniscus* (Linné) from Nassau, Bahamas; *Morionella cancellata* (Lamarck) from the Eocene of France; *Galeodea echinophora* (Linné) from Sicily, Italy; and *Sconsia striata* (Lamarck) from off Yucatan, N.E. Mexico.



Plate 5. Greatly enlarged nuclear whorls of (top), *Phalium (Phalium) glaucum* (Linné) (0.7 mm. in diameter); (center), *Cassis (Hypocassis) nana* Tenison-Woods (1 mm. in diameter); (bottom), *Galeodea echinophora* (Linné) (0.5 mm. in diameter). Photos courtesy of Al Jehle.



sibly this species is dying out in the central areas of its range.

Far to the east, this species is replaced by the quite similar *Cypraccassis tenuis*, which ranges from Baja California and Clipperton to the Galapagos Islands. I suspect that this Eastern Pacific species has descended from formerly wide-spread colonies of the Indo-Pacific *rufa* which perhaps extended to the Eastern Pacific during late Pliocene or early Pleistocene times.

A rather curious, and related, type of distribution exists in the very widely distributed *Casmaria erinaceus*, which extends from Africa to Central America. I have carefully examined all known specimens from the Eastern Pacific, and conclude that they are barely distinguishable from Indian Ocean and East Indian specimens. Yet, between these areas is the intervening and quite distinct subspecies *kalosmodix*, extending from Hawaii in the north to Tonga and Pitcairn in the south. I question that the Eastern Pacific colonies are recent arrivals coming in as free-swimming, long-lived larvae, since the three warm-water currents flowing from the central Pacific (the North Equatorial Counter Current, the Equatorial Undercurrent and the South Equatorial Counter Current) pass through about 2,000 miles of *kalosmodix* territory in Polynesia. Under the circumstances, one would expect the Galapagos and Central American forms to be *kalosmodix*, rather than the East Indian form. It is more reasonable to conjecture that the Eastern Pacific colonies represent residue populations from some former epoch when the distribution of *erinaceus* extended across the entire Indo-Pacific. The subspecies *kalosmodix* is probably a recent development which has either replaced the typical form by competition or filled in the vacancy resulting from the dying out of the typical form by disease or Pleistocene cold periods.

The distribution of cassids, especially in the Indo-Pacific, is rather similar to that of the tropical echinoids (see E. Mayr, 1954, *Evolution*, vol. 8, pp. 1-18) and of the *Myripristis* squirrelfish (see D. W. Greenfield, 1968, *Systematic Zoology*, vol. 17, no. 1, pp. 76-87). The latter underestimates the relatively recent invasion of western Pacific elements into the Indian Ocean in the areas of Cocos-Keeling and the Nicobar Islands (see V. O. Maes, 1967, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 119, pp. 93-217).

## Continental and Oceanic Species

A large proportion of the shallow-water Indo-Pacific cassids fall into one or the other of these two general ecologic groups:

1. Species limited to the rich nitrogenous shores of continents or well-vegetated, "high", volcanic islands.

( <i>Phalium</i> )	( <i>Semicassis</i> )
<i>glaucum</i>	<i>bisulcatum</i>
<i>decussatum</i>	<i>faurotis</i>
<i>baudatum</i>	( <i>Xenophalium</i> )
<i>strigatum</i>	<i>pyrum</i>

2. Species mainly living in clear, oceanic waters surrounding small coral islands, submerged banks or in similar oceanic conditions bordering large islands and continents.

( <i>Cassis</i> )	( <i>Casmaria</i> )
<i>cornuta</i>	<i>erinaceus</i>
( <i>Cypraccassis</i> )	<i>pouderosa</i>
<i>rufa</i>	

## Hybridization

It is likely that interspecific hybrids occur among cassid species. Hybrids between supposedly different species have been experimentally produced in land, fresh-water and marine species. Boss (1964, *Nautilus*, vol. 78, no. 1, pp. 18-21) records a probable cross in nature of *Tellina uagua* and *T. laevigata*, and cites other hybrid records in the literature. Powell (1928, *Trans. and Proc. New Zealand Inst.*, vol. 59, pt. 3, p. 633) records possible natural hybrids between "*Xenophalium labiatum* and *X. insperatum*", and also between subspecies of the buccinid *Verconella adusta*.

Most of these hybrids, including those from the *Cerion* experiments of Bartsch (1925) and the *Viviparus* crossings of V. Franz (1928) are open to question, since there is no evidence that actually different species were involved. In other records of supposed hybrids, such as between *Cypraea eburnea* and *C. miliaris* (R. J. Griffiths, 1960, *The Cowry*, vol. 1, no. 6, p. 94) the true relationship of the parent stocks is uncertain and may be cases of single color gene or subspecific differences.

Powell attempted to substantiate hybridization between the supposedly different cassids, "*Xenophalium labiatum* and *X. insperatum*" by citing

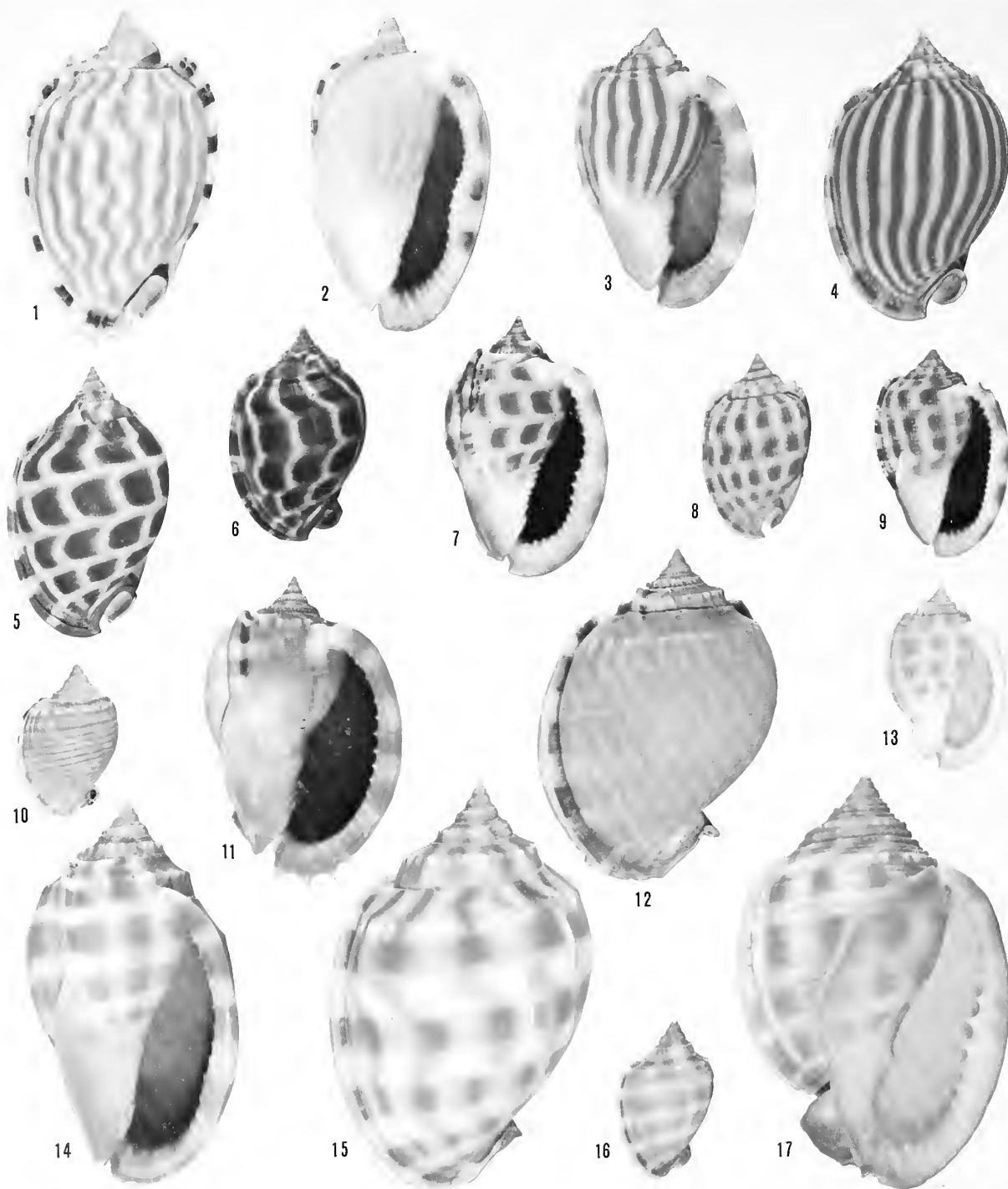


Plate 7

Figs. 1,2. *Phalium fimbria* (Gmelin, 1791). Ceylon.

3,4. *Phalium strigatum* (Gmelin, 1791). Eastern Asia.

5-7. *Phalium arcola* (Linné, 1758). 5 and 7, Queensland, Australia. 6, dark form from Tabaco Bay, Luzon Id., Philippines.

8,9. *Phalium decussatum* (Linné, 1758). Formosa.

10-12. *Phalium glaucum* (Linné, 1758). 10 and 11, young and adult from Mariveles, Luzon Id., Philippines. 12, adult from Bougainville Id., British Solomon Islands.

13. *Phalium arcola* forma *agnitum* Iredale. (young *arcola*). Broome, Western Australia.

14-16. *Phalium bandatum bandatum* (Perry, 1811). 14, off Darwin, Northern Territory, Australia. 15, Olango Id., Cebu Id., Philippines. 16, young from off Cape Ford, Northern Territory, Australia.

17. *Phalium bandatum* subspecies *exaratum* (Reeve, 1848). Seychelles Islands.

(all 1/2 natural size)

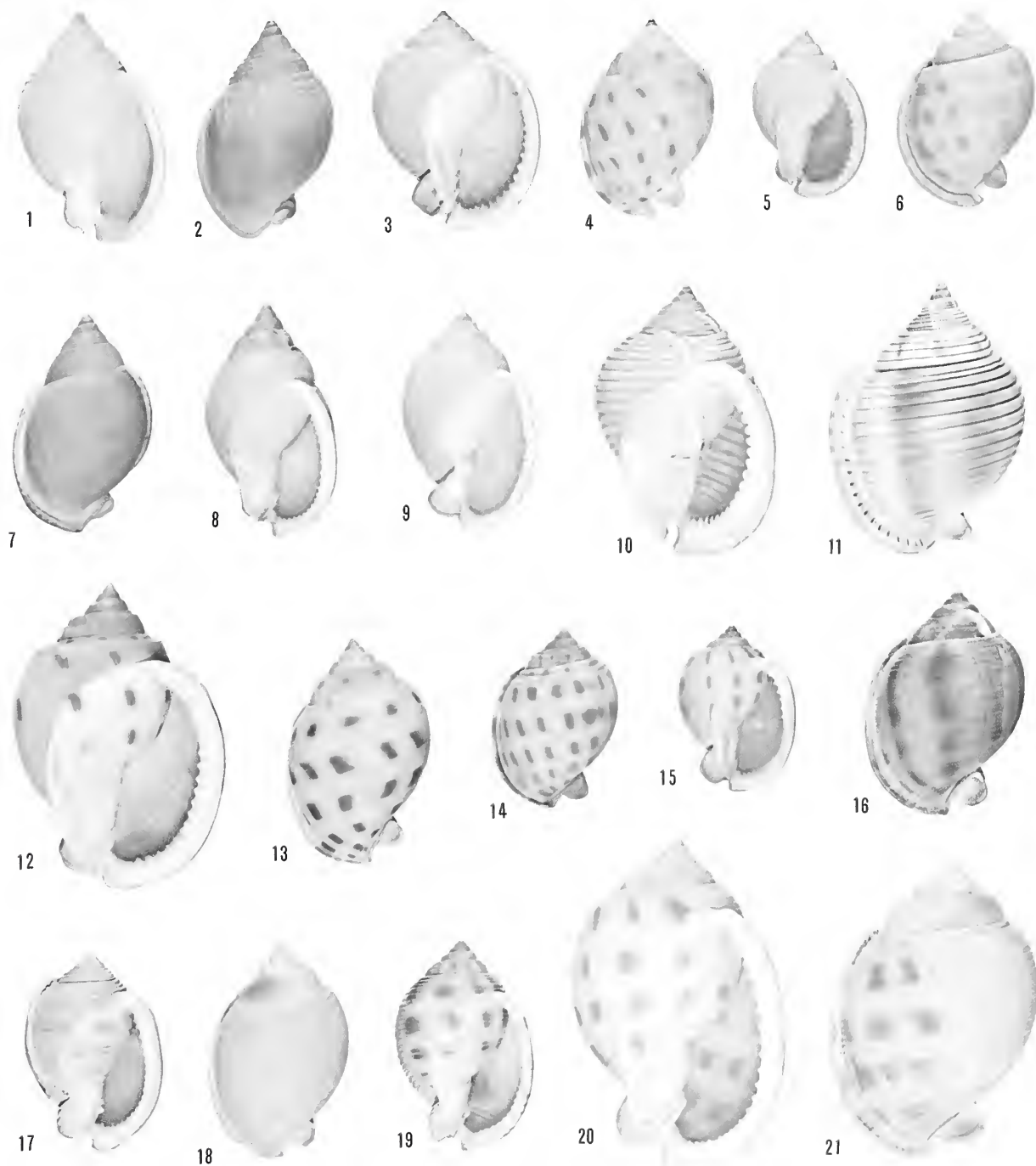


Plate 8

- Figs. 1,2. *Phalium semigranosum* (Lamarck, 1822). 1, Stanley, Tasmania. 2, Encounter Bay, South Australia.  
 3,4. *Phalium faurotis* (Jousseaume, 1888). Chango Id., Zanzibar.  
 5,6. *Phalium canaliculatum* (Bruguère, 1792). Ceylon.  
 7,8. *Phalium glabratum* subspecies *bulla* (Habe, 1961). Ise Bay, Mie-Ken, Honshu Id., Japan.  
 9. *Phalium glabratum* subspecies *angasi* (Iredale, 1927). Off Evans Head, New South Wales, Australia.  
 10,11. *Phalium umbilicatum* (Pease, 1860). 10, cotype from "Sandwich Isles." 11, off Labaina, Maui Id.

- 12-21. *Phalium bisulcatum* (Schubert and Wagner, 1828). 12, subspecies *sophia* (Brazier, 1872) off Cape Moreton, Queensland, Australia. 13, smooth form, Mindoro Id., Philippines. 14 and 15, forma *booleyi* Sowerby, 1900; Andaman Islands, Bay of Bengal. 16, striped form, Tabaco Bay, Luzon Id., Philippines. 17, heavy, corded form, 20 fms., south of Aap Li Chuan, Hong Kong. 18, forma *diurnum* (Iredale, 1927), off Evans Head, N.S.W., Australia. 19, forma *japonicum* (Reeve, 1864), off Tosa, Japan, 50 fms. 20 and 21, forma "*persimile* Kuroda," Mogi, Nagasaki Prefecture, Japan.  
 (all 2/3 natural size)



minor radular differences. However, it should be noted that several authors have recently recorded sexual dimorphism in the radulae of other families (V. O. Maes, 1966, *Nautilus*, vol. 79, no. 3, pp. 73-80; Arakawa, K., 1958, *Venus*, vol. 19, pp. 206-216). I have not examined a sufficient number of radulae of cassids to verify the existence of this kind of sexual dimorphism in the Cassidae.

I believe that *Phalium sophia* from New South Wales, Australia, is probably a hybrid of *P. pyrum* of cool waters and *P. bisulcatum* of tropical waters where the distributions of these two species, representing different subgenera, overlap. A discussion and illustrations are presented under the treatment of the various species. Crossbreeding experiments, correlated with field observations, would probably be very fruitful and illuminating.

#### Evolution within the family

The family appears to have come into being just before or during the Eocene. At that time it appeared in North America and Europe. By the Miocene all of the present-day subgenera were established, and some species of both the Miocene and Pliocene are differentiated very little from those of the Recent.

During the Tertiary there was a tendency towards the development of a strongly recurved siphonal canal and an attending channel or "gutter" just posterior to the canal. Many "cassid" characters, such as the development of a broad, thick parietal shield, and the presence of non-re-absorbed varices, appeared in the early Miocene. These and other characters appeared, disappeared and sometimes reappeared in various unrelated species. Occasionally, two or three of these family characters appear suddenly in Recent species, but are absent in their Pliocene progenitors. This "inter-twining" of important subgeneric-like characters within one or more species makes it impossible to create a nomenclatorial and classificatory hierarchy without resorting to numerous monotypic genera. For this reason our treatment is of a "lumping" nature.

Four main stocks within the family have survived to Recent times—*Galeodea*-related, *Sconsia*-related and *Morum*-related genera and the presently treated group of cassid genera, such as *Cassis*, *Phalium*, *Cypraecassis* and *Casmaria*.

Of the 40 living species treated in detail here, 30 show no apparent degree of subspeciation. Ten show subspeciation. The cases of sympatric species within a given genus, such as *Cyprae-*

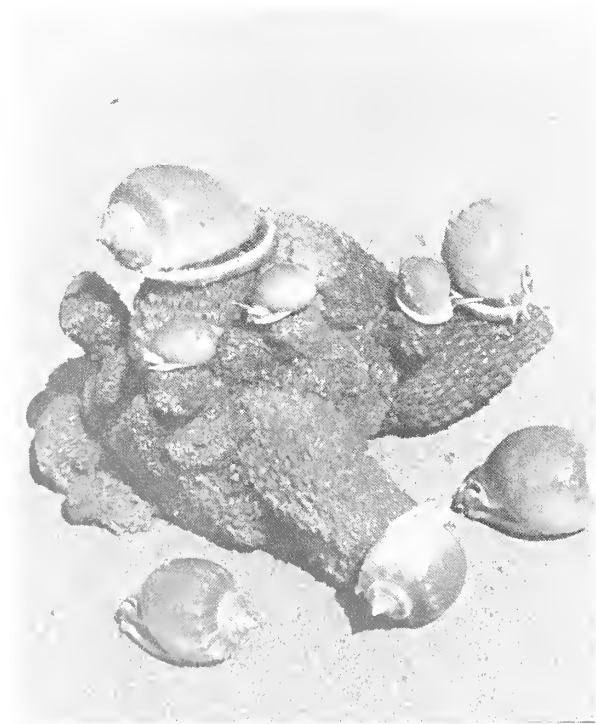
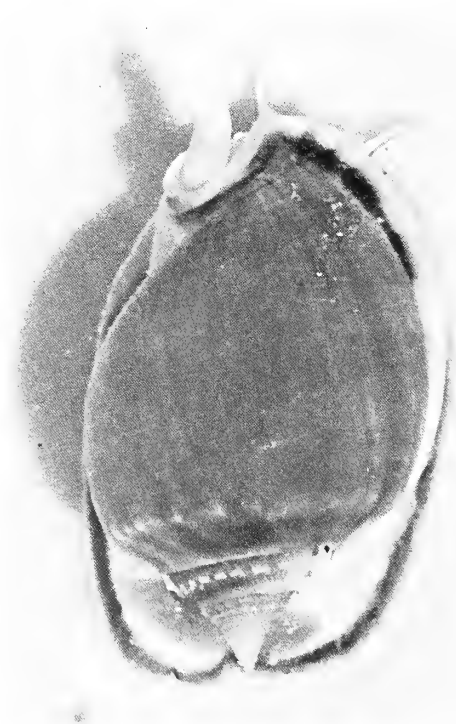


Plate 9. Egg masses of *Phalium glaucum* (Linné). West coast of Malaya, April 1965. Discovered by A. T. Johnson and J. R. Fisher.



Right fig., dorsal view of living *Phalium glaucum* (Linné) from Phuket Island, Thailand (photo by R. T. Abbott).

*cassis tennis* and *coarctata*, or such as *Cassis flammea* and *tuberosa*, demonstrate considerable morphological differences and suggest that their origin lies in the Miocene or earlier.

Cassids were more numerous in species and more widely distributed in the Eocene and Miocene. The subgenera *Manicassis*, *Galeodosconsia* and *Coalingodea* are extinct. *Cassis* was worldwide during the Pliocene, but is now absent in the tropical Eastern Pacific and the Mediterranean Sea.

Among the major mechanisms of evolution is the well-known principle of geographical speciation and its attending isolation. We have been impressed with the dynamic nature of this phenomenon, both in Strombidae (treated in volume 1, no. 2) and the cassids. The evidence from distributional patterns points towards a continual and rather rapid expansion and contraction of geographical limits of many species. This waxing and waning may produce isolated pools, some of which are now worthy of subspecific classification. In connection with changing geographical ranges are varying population densities, which may or may not be correlated with shrinking or expanding distributions. The relative abundance of some species may be influenced by the environment, by inherent genetic changes, or by such

limiting factors as disease, parasites or predators.

As would be expected, every degree of differentiation of geographical isolates are represented among the shallow-water cassids. Some species are very distinctive and show no apparent geographical variation, such as *Cassis cornuta*, *Phalium glaucum* and *Cypraecassis coarctata*. Others show clearly defined subspecies, such as *Phalium glabratum*, *Casmaria ponderosa* and *Phalium bandatum*. A few species show remarkably different forms, due either to minor genetic differences or to ecological influences. *Casmaria erinaceus* (with smooth, light-weight forms or noduled, heavy forms) and *Phalium bisulcatum* (with smooth, colorful forms or coarsely striate, drab forms) are examples of non-geographical variants.

Parenthetically, it should be pointed out that the population samples obtained from deep-water dredgings may be mixtures of colonies representing quite different time origins. Empty shells may represent individuals that lived hundreds or even millions of years ago, the latter being possible if the dredge had sampled a submarine Tertiary outcrop. For these reasons, samples of extreme variability in museum collections do not necessarily represent variations within discrete populations.

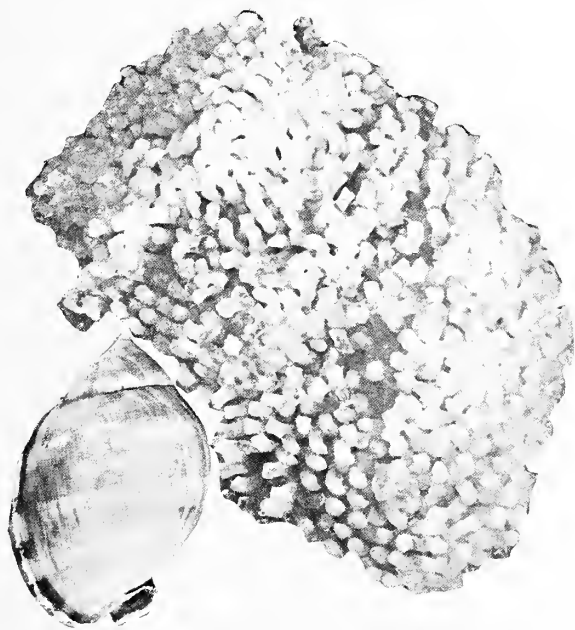


Plate 10. Egg mass (4 in.) of *Phalium labiatum* (Perry) from New Zealand. (from D. T. Anderson, 1966, pl. 10).

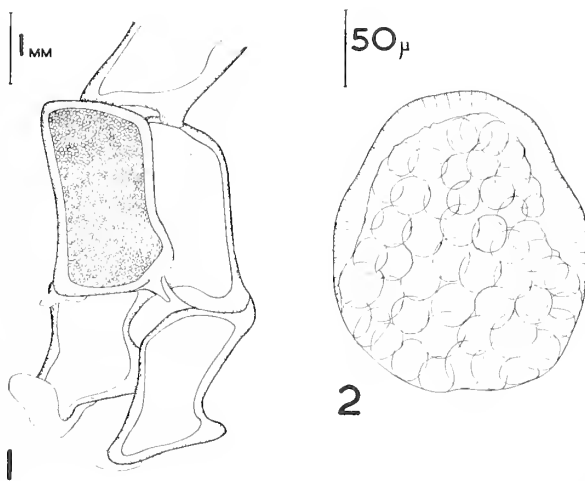


Plate 11. Drawing of egg capsules of *Phalium labiatum* (Perry) from New Zealand. (from D. T. Anderson, 1966, p. 244, figs. 1, 2).

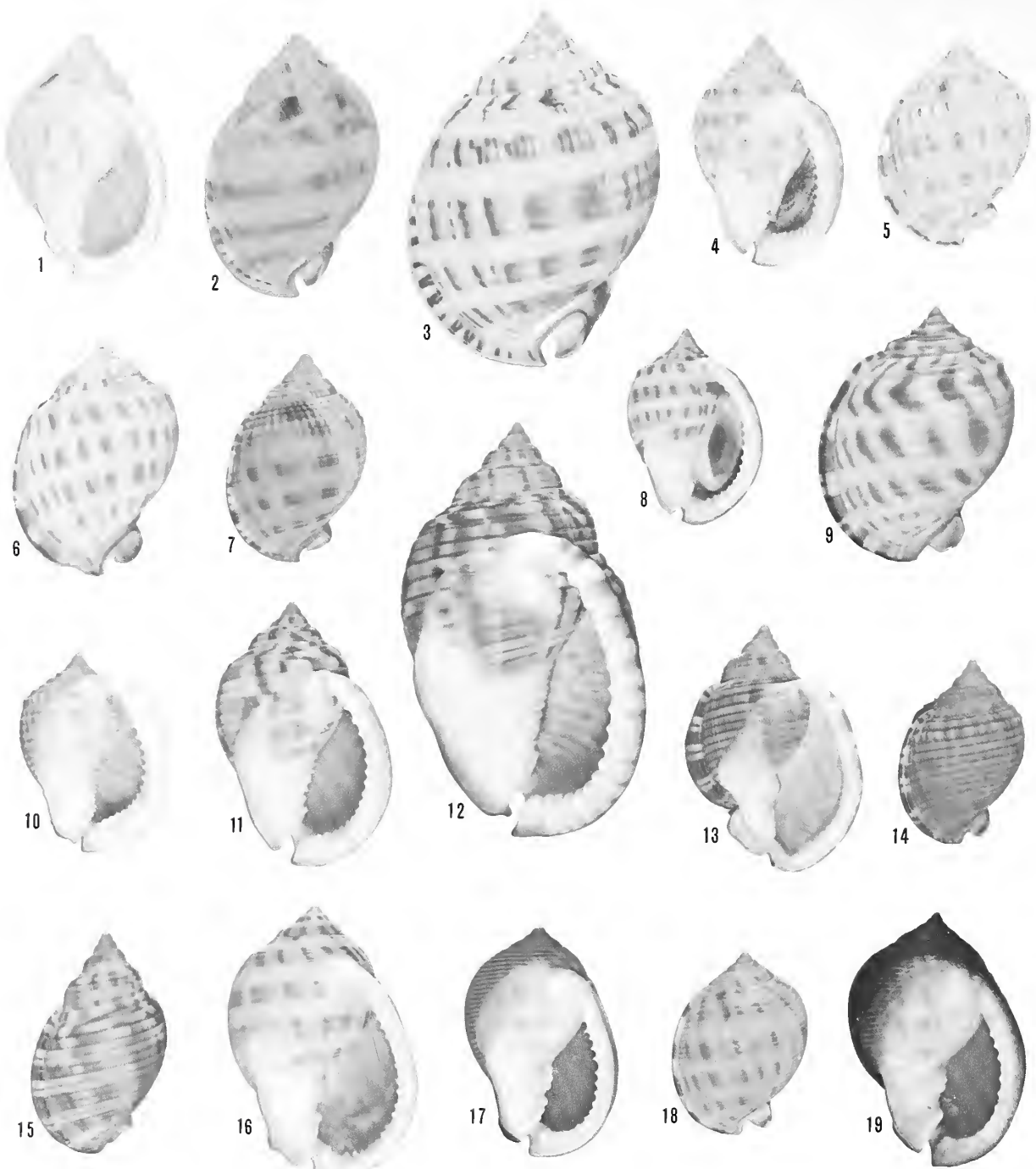


Plate 12

- Figs. 1-7. *Phalium granulatum* (Born, 1778). 1 and 2, forma *cicatricosum* (Gmelin, 1791) from Grand Cayman Id., Caribbean, and Abaco Id., Bahamas. 3, large intermediate form from Bahia, Brazil. 4, typical form from Lake Worth, Florida. 5, forma *peristephes* Pilsbry and McGinty, 1939, from Jensen Beach, Florida. 6, intermediate form from Costa Rica. 7, granulate form from Cape Hatteras, North Carolina.
- 8-10. *Phalium granulatum* subspecies *centiquadratum* (Valenciennes, 1832). 8, Cojímies, Ecuador. 9, off Mazatlán, west Mexico. 10, Acapulco.

- 11-15. *Phalium granulatum* subspecies *undulatum* (Gmelin, 1791). 11, 13 and 15 from Melilla, Spanish Morocco. 12, Aci Trezza, Sicily Id., Italy. 14, Algiers, Algeria.
- 16-19. *Phalium saburon* (Bruguière, 1792). 16, Caparica Beach, Lisbon, Portugal. 17, Melilla, Spanish Morocco. 18, Algeria. 19, Melilla, Spanish Morocco; a black, mud-stained specimen.

(all 2/3 natural size)



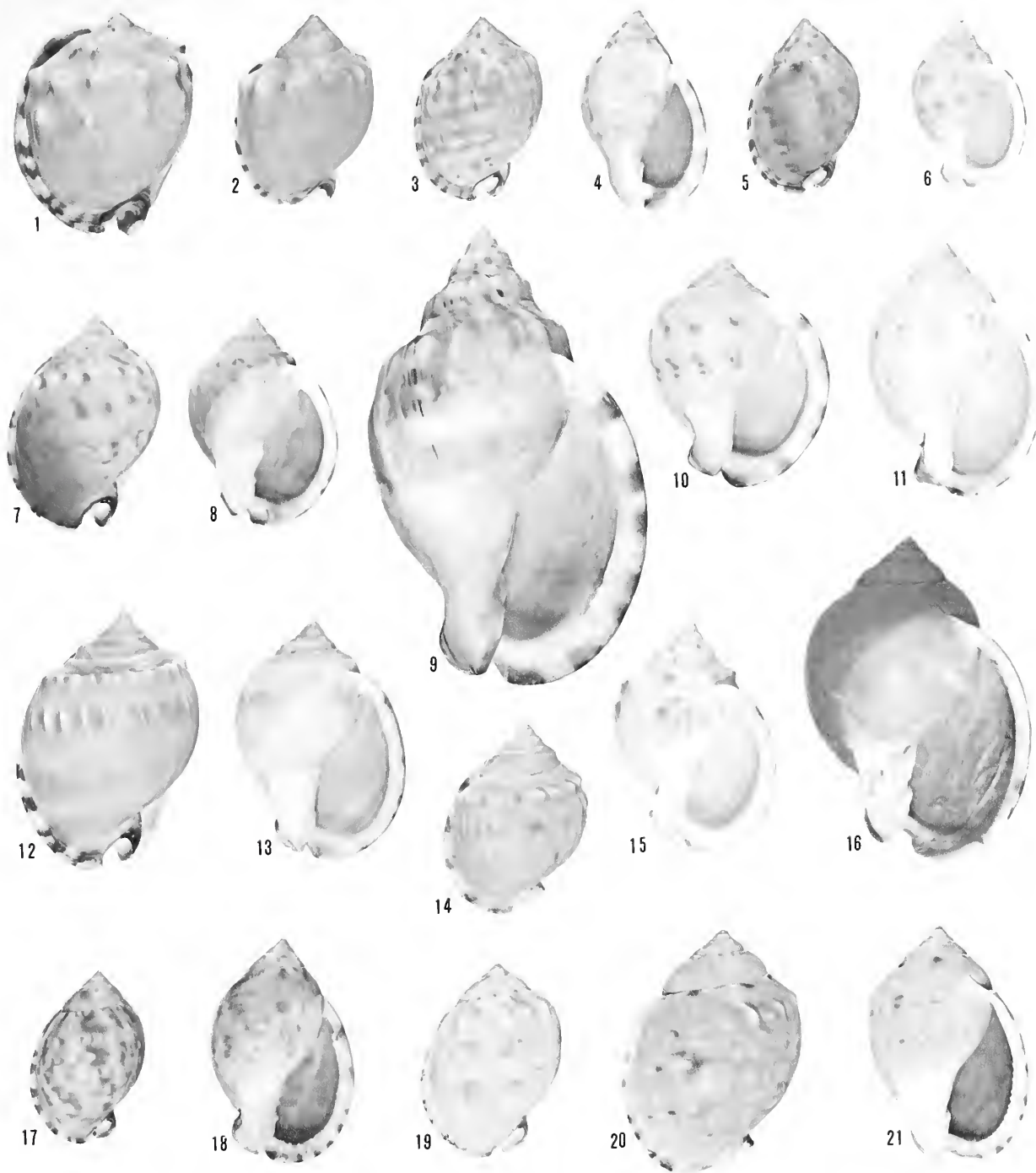


Plate 13

- Figs. 1-5. *Phalium labiatum* subspecies *iredalei* (Bayer, 1935). South Africa. Gradations from the heavy, noded form on the left to the smooth, light-weight, more elongate form on the right.
6. *Phalium inornatum* (Pilsbry, 1895). Wakayama, Honshu Island, Japan.
- 7, 8. *Phalium pyrum* (Lamarck, 1822). North Island, New Zealand.
9. *Phalium pyrum* subspecies *royanum* (Iredale, 1914). 20 fms., off Cavalli Islands, New Zealand.
10. *Phalium pyrum* forma *harrisonae* (Powell, 1928). Stewart Island, New Zealand.
11. *Phalium pyrum* forma *stadiale* (Hedley, 1914). New South Wales, Australia.

12. *Phalium pyrum* forma *spectabile* (Iredale, 1929). Victoria, Australia.
13. *Phalium pyrum* forma *niveum* (Brazier, 1872). South Australia.
- 14, 15. *Phalium thomsoni* (Brazier, 1875). Ulladulla, New South Wales.
16. *Phalium pyrum* forma *finlayi* (Iredale, 1927). Off Otago Heads, New Zealand.
- 17-21. *Phalium labiatum labiatum* (Perry, 1811). La Perouse, N.S.W., Australia. 19, forma *insperatum* (Iredale, 1927), N.S.W., Australia. 20, 21, forma *collectum* (Finlay, 1928), New Zealand.

(all 1/2 natural size)

### Classification of Cassids

The family name Cassididae has been used for the helmet shells by most authors in recent years, but unfortunately there is a chrysomelid beetle family name, Cassididae Gyllenhal, 1813, in current use, which has priority over the molluscan name established by Blainville in 1825. I am adopting the use of the family name Cassidae Swainson, 1832, which has been used by Orbigny, 1837; Eichwald, 1853; Watson, 1882; Gabriel, 1962, and others. Swainson's use appears in his "Zoological Illustrations," series 2, vol. 3, p. 100.

Linnaeus in 1758 placed the 12 species of cassids known to him in the genus *Buccinum*. For nearly a hundred years, Scopoli's 1777 genus *Cassis* was employed by most authors, Deshayes, in 1844, recognized 30 species in *Cassis*, Reeve 33 in 1848, Kobelt 40 in 1876, Ch. Bayer 69 in 1935 and Salmon 70 in 1948. As the number of species grew, additional genera and subgenera were created to accommodate the various groups. About 25 supraspecific names have been proposed. In this review of the Tertiary and Recent world-wide species, it has been necessary to re-evaluate the genera and attempt to recognize the most meaningful and useful ones. The geological history, radulae, nuclear whorls, soft parts, opercula and egg masses have been used in separating the genera. Unfortunately, the family exhibits a complex network of so-called generic relationships, so that some subgenera are very arbitrarily accepted merely for the convenient grouping of certain species. Of the several attempts to organize the phylogeny of the family (Dall, 1909; Ch. Bayer, 1935, and Iredale, 1927), that of A. Wrigley, 1934, is very similar to the one given here.

I depart from Wrigley's classification in removing the Eocene subgenus *Morionella* Dall from the genus *Cassis* and placing it on a generic level next to the genus *Galeodea*. I raise *Cypraecassis* to generic level, and submerge *Semicassis* to a subgenus of *Phalium*. The genera I accept were well-established by Miocene times.

Below is a listing of the accepted genera, subgenera, species and subspecies of Cassidae appearing in Part 1 of this monograph. Those preceded by a dagger (†) are fossil only. The list contains 162 fossil and living world-wide species and subspecies, of which 55 are living. I recognize 23 species and subspecies in the Recent tropical Indo-Pacific.

### List of Recognized Taxa

#### GENUS *Cassis* Scopoli, 1777

##### Subgenus *Cassis* s.s. Scopoli, 1777

- cornuta* (Linné, 1758). Type. Indo-Pacific.
- †*preangerensis* K. Martin, 1899. Miocene; Indonesia.
- †*depressior* K. Martin, 1879. Miocene; Indonesia.
- tuberosa* (Linné, 1758). Western Atlantic.
- †*delta* Parker, 1948. Miocene; S.E. United States.
- †*subtuberosa* Hanna, 1926. Pliocene; California.
- flammea* (Linné, 1758). Western Atlantic.
- madagascariensis* Lamarck, 1822. Western Atlantic.
- †*sulcifera* Sowerby, 1850. Miocene; Caribbean.
- tessellata* (Gmelin, 1791). West Africa.
- †*jogjartensis* K. Martin, 1914. Eocene; Indonesia.
- †*mamillaris* Grateloup, 1827. Miocene; Europe.
- subsp. †*bellardii* Michelotti, 1847.
- subsp. †*postmamillaris* Sacco, 1890.
- subsp. †*apenninica* Sacco, 1890.
- subsp. †*nummulitiphila* Sacco, 1890.
- subsp. †*major* Grateloup, 1827.
- subsp. †*fretusa* Michelotti, 1861.
- †*jauberti* Cossmann and Peyrot, 1924. Miocene; France.
- †*saccoi* Rovereto, 1900. Oligocene; Italy.
- †*thesei* Brongniart, 1823. Eocene; Italy.
- †*vialensis* Fuchs, 1870. Tertiary; Italy.

##### Subgenus *Coalingodea* Durham, 1942

- †*tuberculata* Gabb, 1864. Type. Eocene; west United States.

##### Subgenus *Hypocassis* Iredale, 1927.

- fimbriata* Quoy and Gaimard, 1833. Type. Australia.
- †*exigua* Tenison-Woods, 1879. Tertiary; Australia.
- †*salisburyensis* Ludbrook, 1958. Pliocene; Australia.
- nana* Tenison-Woods, 1879. Eastern Australia.
- †*torva* (Iredale, 1927). Tertiary; Australia.
- †*textilis* Tate, 1882. Oligocene; Australia.

**GENUS** *Cypraecassis* Stutchbury, 1837.**Subgenus** *Cypraecassis* Stutchbury, 1837.*cnfa* (Linné, 1758). **Type.**

Recent; Indo-Pacific.

†*pustulata* (Cox, 1927). Miocene;

East Africa.

*testiculus* (Linné, 1758). Recent;

Atlantic.

subsp. *senegalica* (Gmelin, 1791).

Recent; Eastern Atlantic.

†*subtesticulus* (Orbigny, 1852). Miocene;

Europe.

†*cypraeiformis* (Borson, 1820). Miocene;

Europe.

†*psendocrumena* (Sacco, 1890). Pliocene;

Europe.

†*subcrumena* (Orbigny, 1852). Miocene;

Europe.

*tenuis* (Wood, 1828). Recent;

Eastern Pacific.

**Subgenus** *Levenia* Gray, 1847.*coarctata* (Sowerby, 1825). **Type.**

Recent; Eastern Pacific.

**GENUS** *Phalium* Link, 1807.**Subgenus** *Phalium* Link, 1807.*glancnu* (Linné, 1758). **Type.** Recent;

Indo-Pacific.

*bandatum* (Perry, 1811). Recent;

Western Pacific.

subsp. *exaratum* (Reeve, 1848). Recent;

Indian Ocean.

*areola* (Linné, 1758). Recent; Indo-Pacific.subsp. †*vavakuana* (Ladd, 1934).

Miocene; Fiji.

subsp. †*glaucoides* (K. Martin, 1879).

Miocene; Java.

†*menkrawitense* Beets, 1941. Miocene;

Borneo.

*strigatum* (Gmelin, 1791). Recent;

East Asia.

*decussatum* (Linné, 1758). Recent;

Western Pacific.

†*cancellianum* Nomura, 1935. Pliocene;

Taiwan.

*fimbria* (Gmelin, 1791). Recent;

central Indo-Pacific.

†*darchiaci* Noetling, 1895. Oligocene;

Burma.

**Subgenus** *Echinophoria* Sacco, 1890.†*intermedium* (Brocchi, 1814).**Type.** Tertiary; Italy.†*rondeleti* (Basterot, 1825). Tertiary;

Europe.

†*megapolitanum* (Beyrich, 1854).

Oligocene; Europe.

†*haueri* (Hoernes and Auinger, 1884).

Miocene; Austria.

*coronadoi* (Crosse, 1867). Recent;

Caribbean.

subsp. *wyvillei* (Watson, 1886). Recent;

Western Pacific.

†*bituminatum* (K. Martin, 1933). Pliocene;

Indonesia.

†*vandervlerki* (K. Martin, 1933). Pliocene;

Indonesia.

*bituberculosum* (von Martens, 1901).

Recent; Indian Ocean.

*carnosum* (Kuroda and Habe, 1961).

Recent; Japan.

*knrodai* Abbott, 1968. Recent; Japan.†*etchuense* (Hatai and Nisiyama, 1949).

Miocene; Japan.

*pilsbryi* (Woodring and Olsson, 1957).

Recent; Galapagos.

†*andersoni* Abbott, 1968. Miocene;

Columbia.

†*hadrum* (Woodring and Olsson, 1957).

Pliocene; Panama.

†*apenes* (Woodring, 1959). Oligocene;

Canal Zone.

†*woodringi* (Olsson, 1964). Neogene;

Ecuador.

†*tuberculiferum* (Hupé, 1854). Tertiary;

Chile.

†*taitii* (Conrad, 1834). Eocene;

S.E. United States.

†*trituberculatum* (Weaver, 1912). Eocene;

western United States.

†*dalli* (Dickerson, 1917). Oligocene;

western United States.

†*oconnori* (Dell, 1952). Miocene;

New Zealand.

†*grangei* Marwick, 1926. Miocene;

New Zealand.

†*oneroaensis* (Powell, 1938). Miocene;

New Zealand.

†*hectori* Abbott, 1968. Miocene;

New Zealand.

†*torenma* (Powell, 1928). Miocene;

New Zealand.

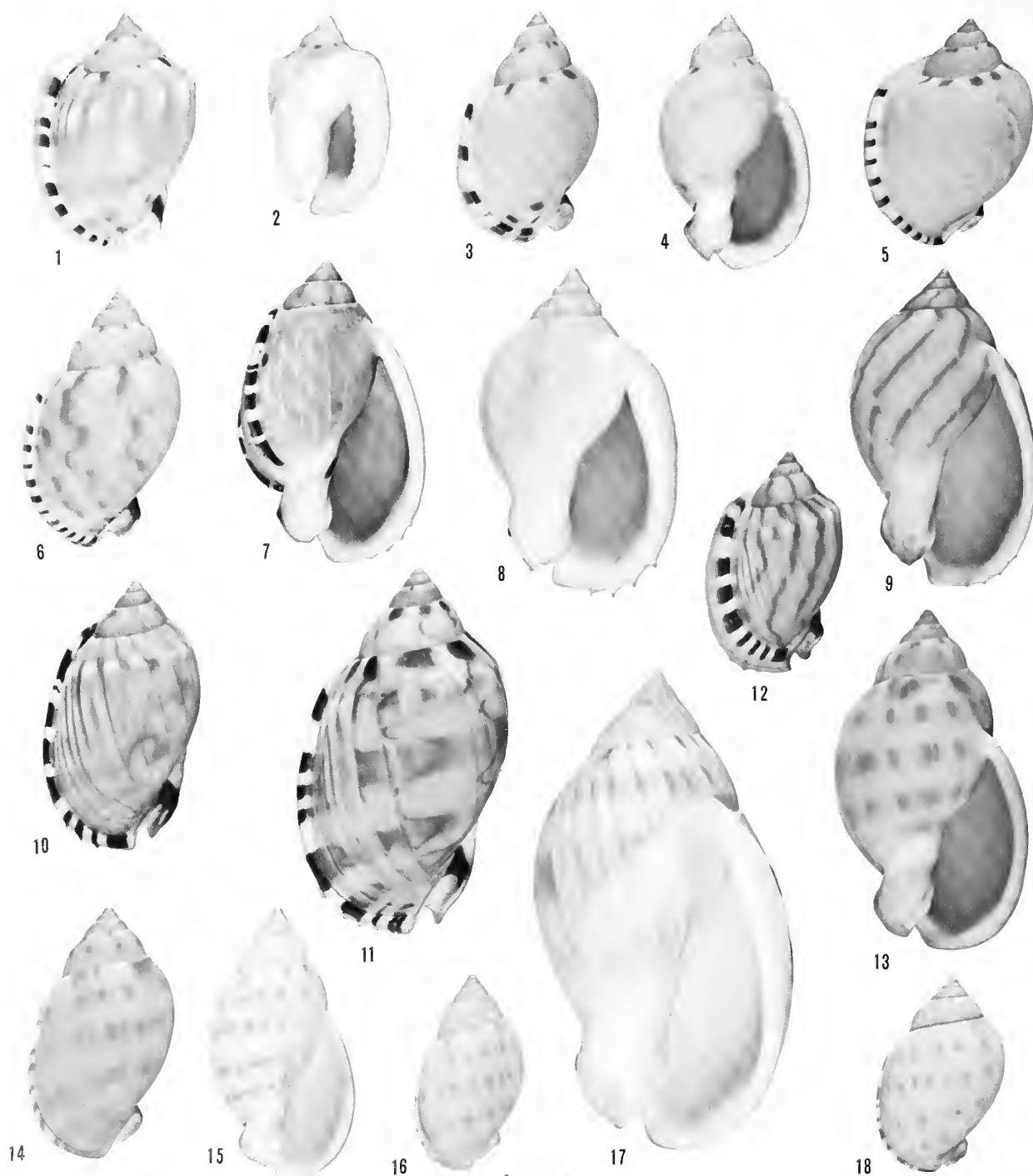


Plate 14

- Figs. 1-6. *Casmaria ponderosa* (Gmelin, 1791). 1 and 2, plicate or *nodulosa* Gmelin form, Attue, Tahiti Id., Society Islands. 3 and 4, smooth form, Ryukyu Islands. 5, subspecies *unicolor* Dautzenberg from Eilat, Red Sea. 6, striped form, *turgida* Reeve, 1848, Bohol Id., Philippines.
- 7-12. *Casmaria erinaceus* (Linné, 1758). 7, malformed specimen of form *vibex* (Linné, 1758), with extra varix; Bohol Id., Philippines. 8, typical form from Aeri Ids., Geelvink Bay, Dutch New Guinea. 9, striped form of forma *vibex* (Linné, 1758), central Philippines. 10, typical *erinaceus* form, Cuyo Id., Philippines. 11, Polynesian form with subsutural flames, Tutuila Id., Samoa. 12, striped

- form *erinaceus* (Linné), Bougainville Id.
- 13, 14. *Casmaria erinaceus nipponensis* Abbott, new subspecies. 13, holotype, Tanabe, Honshu Id., Japan. 14, paratype, Wakayama, Japan.
- 15, 16. *Casmaria erinaceus atlantica* Clench, 1944. 15, Bimini Id., Bahamas. 16, paratype, MCZ 134574, Matthew Town, Great Inagua Id., Bahamas.
17. *Casmaria erinaceus* subspecies *kalosmodix* (Melville, 1883). Pearl and Hermes Reef, Hawaiian Islands.
18. *Casmaria ponderosa* form *cernica* (Sowerby, 1888). Mauritius.

(all natural size)



**Phalium (Echinophoria) cont'd.**

- †*multinodosum* (Powell, 1928). Miocene;  
New Zealand.
- †*emilyae* (Laws, 1932). Miocene;  
New Zealand.
- †*pollens* (Finlay, 1926). Miocene;  
New Zealand.
- †*trinodosum* (Tate, 1889). Oligocene;  
Australia.

**Subgenus *Mauicassis* Fleming, 1943.**

- †*fibratum* Marshall and Murdoch, 1920.  
**Type.** Pliocene; New Zealand.
- †*kaawaense* (Bartrum and Powell, 1928).  
Pliocene; New Zealand.
- †*lilliei* (Fleming, 1943). Pliocene;  
New Zealand.
- †*marwicki* (Fleming, 1943). Pliocene;  
New Zealand.
- †*onishpetensis* Otuka, 1937. Miocene;  
Japan.
- †*yokoyamai* Nomura and Hatai, 1933.  
Pliocene; Japan.
- †*yabei* Nomura and Hatai, 1933. Pliocene;  
Japan.
- †*petrosum* (Conrad, 1849). Miocene;  
N.W. United States.
- †*fax* (Tegland, 1931). Oligocene;  
N.W. United States.
- †*rex* (Tegland, 1931). Oligocene;  
N.W. United States.
- †*apta* (Tegland, 1931). Oligocene;  
N.W. United States.
- †*tegalensis* (K. Martin, 1899). Pliocene;  
Indonesia.

**Subgenus *Galeodosconsia* Sacco, 1890.**

- †*striatulum* (Bellardi and Michelotti, 1841).  
**Type.** Miocene; southern Europe.
- †*calantica* (Deshayes, 1835). Tertiary;  
Europe.
- †*striatum* (J. Sowerby, 1812). Tertiary;  
Europe.
- †*augustana* (Wrigley, 1934). Eocene;  
England.
- †*brevicostatum* (Conrad, 1834). Eocene;  
S.E. United States.  
subsp. †*creolum* Palmer, 1947. Eocene;  
S.E. United States.
- †*hodgii* (Conrad, 1841). Miocene;  
S.E. United States.
- †*nuperum* (Conrad, 1833). Eocene;  
S.E. United States.

**Subgenus *Semicassis* Mörch, 1852.**

- †*bisulcatum* (Schubert and Wagner, 1829).  
**Type.** Miocene-Recent;  
Indo-Pacific.
- subsp. *sophia* (Brazier, 1872). Recent;  
Australia.
- †*canaliculatum* (Bruguière, 1792). Recent;  
Bay of Bengal.
- †*faurotis* (Jousseaume, 1888). Recent;  
Indian Ocean.
- †*umbilicatum* (Pease, 1860). Recent;  
Hawaiian Chain.
- †*multisectum* (Finlay, 1924). Pliocene;  
New Zealand.
- †*skinneri* Marwick, 1928. Miocene;  
New Zealand.
- †*microstoma* (von Martens, 1903). Recent;  
Indian Ocean.
- †*sufflatum* (Tenison-Woods, 1877).  
Tertiary; Australia.
- †*mekranicum* (Vredenburg, 1925).  
Miocene; India.
- †*oligocalanticum* (Vredenburg, 1925).  
Oligocene; India.
- †*sculptum* (J. Sowerby, 1840). Miocene;  
India.
- †*denseplicatum* (K. Martin, 1916).  
Miocene; Indonesia.
- †*turricula* Dall, 1909. Tertiary;  
N.W. United States.
- †*egberti* Schenck, 1926. Oligocene;  
N.W. United States.
- †*tiani* Schenck, 1926. Oligocene;  
N.W. United States.
- †*aequisulcatum* Dall, 1909. Tertiary;  
N.W. United States.
- †*oregonense* (Dall, 1909). Oligocene;  
N.W. United States.
- †*glabratum* (Dunker, 1852). Recent;  
S.W. Pacific.  
subsp. *angasi* (Iredale, 1927). Recent;  
Australia.
- subsp. *bulla* (Habe, 1961). Recent; Japan.
- †*semigranosum* (Lamarck, 1822). Recent;  
southern Australia.
- †*muelleri* (Tate, 1889). Pliocene;  
southern Australia.
- †*adcocki* (Sowerby, 1896). Recent;  
southern Australia.
- †*sinuosum* (Verco, 1904). Recent;  
southern Australia.

**Phalium (Semicassis) cont'd.**

- saburon* (Bruguère, 1792). Recent;  
Eastern Atlantic.  
subsp. †*adami* (Eichwald, 1830).  
Miocene; Europe.  
subsp. †*deucalion* (Eichwald, 1830).  
Miocene; Europe.  
subsp. †*affine* (Philippi, 1847). Tertiary;  
Europe.  
†*laevigatum* (Defrance, 1817). Pliocene;  
Europe.  
†*miolaevigata* Sacco, 1890. Miocene;  
Europe.  
†*grateloupi* (Deshayes, 1850). Miocene;  
Europe.  
†*incrassatum* (Gratoloup, 1834). Miocene;  
Europe.  
†*bicoronatum* (Beyrich, 1854). Tertiary;  
Europe.  
†*subsulcosa* (Hoernes and Auinger, 1884).  
Miocene; Europe.  
†*reticulata* (Bellardi and Micheliotti, 1841).  
Miocene; Italy.  
†*neumayri* (R. Hoernes, 1875). Miocene;  
Europe.  
†*hoernes* (Sacco, 1890). Miocene; Italy.  
†*striatella* (Gratoloup, 1827). Miocene;  
Europe.  
†*subareola* (Orbigny, 1852). Tertiary;  
France.  
*craticulatum* (Euthyme, 1885). Recent;  
South Africa.

**Subgenus Tylocassis Woodring, 1928.**

- granulatum* (Born, 1778). **Type.** Recent;  
Western Atlantic.  
subsp. *undulatum* (Gmelin, 1791).  
Recent; Eastern Atlantic.  
subsp. *centiquadratum* (Valenciennes,  
1832). Recent; Eastern Pacific.  
subsp. †*aldrichi* Dall, 1890. Miocene;  
Florida.  
subsp. †*reclusum* (Guppy, 1873).  
Miocene; Caribbean.  
†*caelaturum* (Conrad, 1848). Oligocene;  
Mississippi.

**Subgenus Xenophalium Iredale, 1927.**

- pyrum* (Lamarck, 1822). Recent; Australia;  
New Zealand; South Africa.  
subsp. *royanum* (Iredale, 1914). **Type.**  
Recent; Australia-New Zealand.  
*pauciruge* (Menke, 1843). Recent;  
Western Australia.  
†*radiatum* (Tate, 1889). Miocene;  
S.E. Australia.  
*thomsoni* (Brazier, 1875). Recent;  
Australia-New Zealand.  
*whitworthi* Abbott, 1968. Recent;  
Western Australia.  
*inornatum* (Pilsbry, 1895). Recent; Japan.  
†*gradiferum* (Cossmann and Pissarro,  
1909). Eocene; India.  
†*moniliferum* (Sowerby, 1846). Tertiary;  
Chile.  
*labiatum* (Perry, 1811). Recent;  
Australia-New Zealand.  
subsp. *iredalei* (Bayer, 1935). Recent;  
South Africa.  
subsp. *iheringi* (Carcelles, 1953). Recent;  
Brazil-Argentina.

**GENUS Casmaria H. and A. Adams, 1853.**

- erinaceus* (Linné, 1758). Recent;  
Indo-Pacific.  
subsp. *kalosmodix* (Melvill, 1883).  
Recent; Polynesia.  
subsp. *vibexmexicana* (Stearns, 1894).  
Recent; Eastern Pacific.  
*ponderosa* (Gmelin, 1791). Recent;  
Indo-Pacific.  
subsp. *unicolor* (Dautzenberg, 1926).  
Recent; N.W. Indian Ocean.  
subsp. *perryi* (Iredale, 1912). Recent;  
South Pacific.  
subsp. *nipponensis* Abbott, 1968. Recent;  
Japan.  
subsp. *atlantica* (Clench, 1944). Recent;  
Caribbean.

## Doubtful Species of Cassids

This section contains names of *Cassis* which are either invalid, unidentifiable, or now known to belong to genera other than those treated in this monograph. They are included so that the index to this section will constitute as complete as possible a catalog of all known *Cassis*, *Phalium*, *Cypræocassis* and *Casmaria* names. The genus *Galeodea* Link (*Cassidaria* Lamarck) will be treated in a subsequent monograph.

In 1787, Mueschen published his "Schediasma Systematis Testaceorum" (pp. 234-494) in the Museum Geversianum (à la Haye, 1787) and employed all of his genera in the pleural form or in several word forms. As Winkworth pointed out in 1926 (Proc. Mal. Soc. London, vol. 17, pp. 103-104), none of Meuschen's names should be accepted, since they are not strictly binomial. Curiously, Sherborn listed all the species in his "Index Animalium", and changed each genus to its singular form. Thus "*Cassides chartoprates* Meuschen" is listed as "*Cassis chartoprates* Meuschen". A list of these names appears below. None is valid and none preoccupies later names in *Cassidea* or *Cassis*. There is no nomenclatorial or taxonomic point in properly identifying them: *auus*, *sulcata*, *penita*; *glabrata*, *coacta*, *spirata*, *cuueata*, *chrysostoma*, *glabra*, *pollicaris*, *vellicata*, *arcularia*, *plicata*, *clatrata*, *perlata*, *gibbosula*, *geminata*, *maculata*, *geometrica*, *areolus*, *alveolus*, *striata*, *cicatricosa*, *tuberculata*, *ziczac*, and *chartoprates* (all Meuschen, 1787, pp. 386-395, so-called genus "Cassides").

A number of *nomen nudum* were created by R. B. Newton in 1891 (Systematic List of the Frederick E. Edwards Collection of British Oligocene and Eocene Mollusca in the British Museum, xxviii + 365 pp.). They have crept into the literature over the years, and a few of the names have been subsequently validated, even though they are synonyms (Wrigley, 1934). Nude names are *Cassis contabulata* "Edwards, MS" Newton; *Cassis geminata* "Edwards, MS" Newton (now *Galeodea geminata* Wrigley,

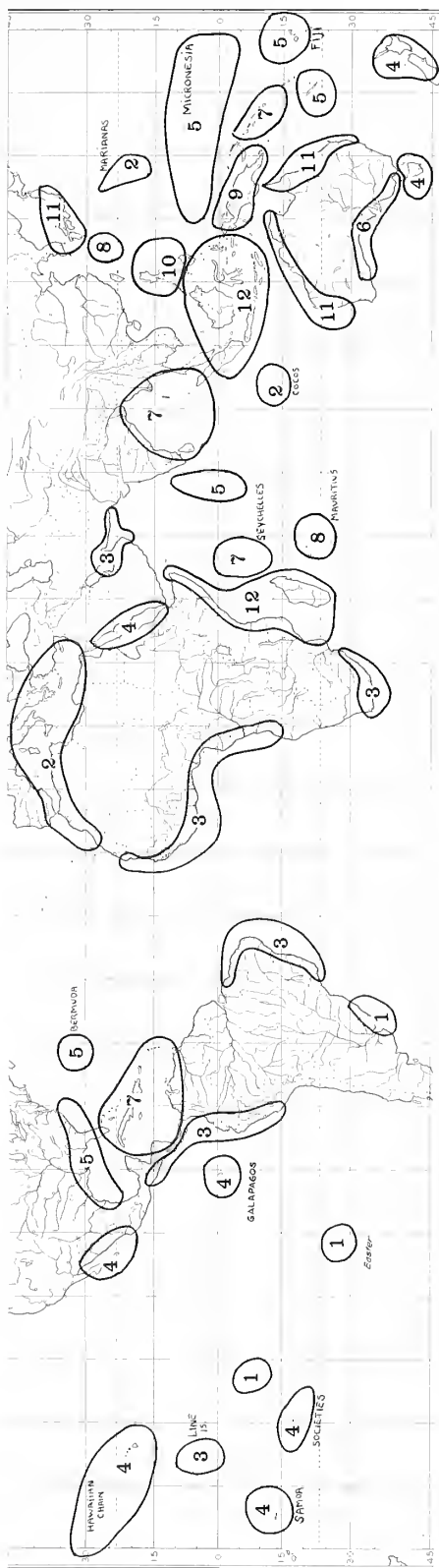


Plate 15. Number of living species and races of cassids inhabiting selected areas of the world (*Cassis*, *Cypræocassis*, *Phalium* and *Casmaria*). Insufficiently collected areas have been omitted, and some of the present censuses will probably increase by about 10 percent when additional records, particularly deep sea ones, are found. For a comparison with a more tropical family, see a similar map of *Strombus*, vol. 1, no. 1, p. 40 [looseleaf p. 09-838].

1934); *Cassis gigantea* "Edwards, MS" Newton (is *Galeodea bullata* T. Brown, 1839); *Cassis nodosa* var. *edentula* "Edwards, MS" Newton (is form *retusa* Deshayes, 1865); *Cassis nodosa* var. *funicincta* "Edwards, MS" Newton (now form *funicincta* Wrigley, 1934); var. *subenodis* "Edwards, MS" Newton (now form *subenodis* Wrigley, 1934); *Cassis spinosa* "Edwards, MS" Newton; *Cassis substriata* "Edwards, MS" Newton (now *Galeodea gallica* form *clarendonensis* Wrigley, 1934); *Cassis tessellata* "Edwards, MS" Newton (now *Sconsia ambigua* form *tessellata* Wrigley, 1934); *Cassis venatrix* "Edwards, MS" Newton (is *Galeodea coronata* Deshayes, 1830).

### **Cassidea acanthina Dalton, 1908**

*Range*—Miocene of Burma.

*Remarks*—The large, massive, 100-mm.-long gastropod with two rows of large spines on the lower third of the last whorl very doubtfully belongs to the family Cassidae. No columellar or outer lip characters are preserved in the only known specimen. Dalton assigned it to *Cassidea*, i.e. *Cassis*.

#### *Synonymy*—

1908 *Cassidea acanthina* Dalton, Quart. Jour. Geol. Soc. London, vol. 64, p. 629, pl. 57, fig. 1 (1.5 mi. north of Lanywa, Pakokku District, Burma; Miocene).

### **Cassis aegyptiaca Oppenheim, 1906**

*Remarks*—This poorly preserved and poorly illustrated species may well be a *Tonna*.

#### *Synonymy*—

1906 *Cassis aegyptiaca* Oppenheim, Palaeontographica, Cassel, vol. 30, p. 307, pl. 24 (Lutetian, Egypt).

### **Semicassis anceps H. and A. Adams, 1858**

*Remarks*—This name was proposed for a figure of a living cassid, but the shell represents a young form of either a *Casmaria* or a *Xenogalea*. The type specimen has not been located.

#### *Synonymy*—

1858 *Semicassis anceps* H. and A. Adams, Genera of Recent Mollusca, London, vol. 1, p. 215, pl. 23, fig. 2 (no locality).

### **Cassidea (Semicassis) anteniana K. Martin, 1931**

*Range*—Upper Eocene, Nanggoelan beds of Java, Indonesia.

*Remarks*—K. Martin likened his species to *Cassidaria desori* d'Archiac and Haime, 1854,

from the Eocene-Miocene, Gáj of Sind, India. I believe both of these species belong to *Galeodea*, and they will be treated in a subsequent monograph.

#### *Synonymy*—

1931 *Cassidea (Semicassis) anteniana* K. Martin, Wetenschap. Mededeel., no. 18, Dienst. Mijnbouw Nederlandsch-Indië, p. 32, pl. 5, figs. 2, 2a (Kali Anten, Nanggoelan beds, Java; Upper Eocene).

### **Cassis archiaci Bellardi, 1852**

*Remarks*—This fossil may be a *Cypraecassis* or a *Voluta*.

#### *Synonymy*—

1852 *Cassis archiaci* Bellardi, Mémoires Soc. Géologique de France, ser. 2, vol. 4, p. 224, pl. 14, figs. 3 and 5 (La Palarea, Nice, France, Tertiary).

### **Cassidaria arntzenii K. Martin, 1914**

*Range*—Upper Eocene, Nanggoelan beds of Java, Indonesia.

*Remarks*—As a species, *arntzenii* is very distinctive, but its proper generic placement will be impossible to make until more complete specimens are discovered. The strong distorted teeth on the columella and the spiral cords on the body whorl suggest the genus *Quimalea* in the family Tonnidae. However, there are suggestive features both in the beading of the spiral cords and in the strong plicae on the upper portion of the parietal wall that lead me to believe that this may be a forerunner of the *Tylorcas* or *Semicassis* stock. The unique shell, 21.8 mm. in length, is badly broken and has its apex and siphonal canal absent.

#### *Synonymy*—

1914 *Cassidaria arntzenii* K. Martin, Samml. Geol. Reichsmus., Neue Folge, vol. 2, p. 155, pl. 5, figs. 119, 119a (Kali Puru, Nanggoelan beds, Java; Upper Eocene).  
1943 *Galeodea arntzenii* (Martin) Beets, Verh. Geol. Mijnbouw Gen. Geol. Serie, vol. 13, pp. 436-437 (Upper Eocene).

### **Cassis avellana Brongniart, 1822**

*Remarks*—This species belongs to the family Ringiculidae and is the type of the genus *Avellana* Orbigny, 1843.

### **Cassis beyrichi Michelotti, 1861**

*Remarks*—This is a *Sconsia* from the Oligocene to the Pliocene of Italy, India, Burma and Java (Etude Miocene Infer., p. 132, pl. 13, figs. 7, 8).



**Cassis bicatenatus J. Sowerby, 1817**

*Remarks*—This evidently is a fossil species of *Galeodea* described in Mineral Conchology of Great Britain, vol. 2, p. 117.

**Cassis bilineata Fleming, 1828**

*Remarks*—What may be either a young *Cypræcassis testiculus* (Linné) or a young *Phalium* (*Semicassis*) *granulatum* (Born, 1778), was figured by Pennant in 1777 in his British Zoology, ed. 4, vol. 4, pl. 79 (bottom figures), and was given the name *Cassis bilineata* by Fleming (1828, Hist. British Animals, p. 339). The name *Buccinum porcatum* Pulteney, 1799 (Cat. Birds, Shells.....Dorsetshire, London, p. 41) was also given to this questionable figure. A more detailed account occurs in Forbes and Hanley, 1853, History of British Mollusca, London, vol. 3, p. 447.

**Cassidea breistrofferi Delpey, 1942**

*Remarks*—The poor condition of the shells does not permit assignment of this species to any cassid genus, or in fact, even to the family. In the same paper, Delpey assigns *Fusus sabaudii* Pictet and Roux, 1849, to the genus *Cassidea*, but I question if this species is a cassid.

*Synonymy*—

1942 *Cassidea breistrofferi* Delpey, Travaux Laboratoire Géol. Univ. de Grenoble, vol. 23, p. 93, pl. 2, figs. 21, 22 (l'Albien inférieur de La Frassette, France).

**Cassis brunnea Röding, 1798**

*Remarks*—This name was proposed for Lister's plate 1011, figure 71f which is a *Galeodea* and will be discussed in a future monograph (Museum Boltenianum, Hamburg, pt. 2, p. 30, no. 363).

**Cassis caelata Conrad, 1830**

*Remarks*—This small, attractive Oligocene species is, I believe, a *Galeodea*.

*Synonymy*—

1830 *Cassis caelata* Conrad, Jour. Acad. Nat. Sciences Philadelphia, vol. 6, p. 218.

**Cassis callosa Röding, 1798**

*Remarks*—This name is based upon a figure of a *Nassarius* (Knorr, pt. 6, pl. 22, fig. 6).

**Cassis canaliculata Risso, 1826**

*Remarks*—This 31 mm.-long, fossil European cassid is unknown to me. It was not illustrated. The name is preoccupied by *Cassis canaliculata* Bruguière, 1792.

*Synonymy*—

1826 *Cassis canaliculata* Risso, Histoire Naturelle. . . . . de L'Europe Méridionale, vol. 4, p. 181 (la Trinité).

**Cassis cancellata Röding, 1798**

*Remarks*—Röding in his Museum Boltenianum, Hamburg, pt. 2, p. 30 and 31, described two species by this name, the first probably being a *Nassarius*, and the second being a synonym of *Phalium decussatum* Linné, a Recent species from the southwest Pacific and eastern Asia. I hereby declare both of these as *nomena oblita* in order to preserve the well-known name of the Eocene species, *Cassis cancellata* Lamarck, 1803, and apply to the International Commission on Zoological Nomenclature for action.

**Cassidea carinata Bruguière, 1792**

*Remarks*—According to Wrigley, 1934, p. 120, this fossil is a form of *Galeodea nodosa* Solander, 1766. This is also *Cassis carinata* Lamarck, 1803.

**Cassis carinata Lamarck, 1803**

*Remarks*—This is a synonym of *Galeodea nodosa* Solander, 1766.

*Synonymy*—

1803 *Cassis carinata* Lamarck, Annales Mus. Hist. Naturelle Paris, vol. 2, no. 2, p. 169.

**Cassis carinata J. Sowerby, 1812**

*Remarks*—This is a homonym and was renamed *Galeodea gallica* Wrigley, 1934, Proc. Mal. Soc. London, vol. 21, p. 123, where he gives a complete synonymy.

**Ceiba ceibaensis Clark and Durham, 1946**

*Remarks*—When proposing this new genus and species from the Eocene of Bolivar, Colombia, the authors placed them in the family Cassidae [Cassidae], but considering the volutid-like features of this elongate, narrow shell, and considering the extent to which other members of that fauna had developed their classic Tertiary features, I am more inclined to place

*Ceiba* in the Volutidae rather than the Cassidae. The original descriptions appeared in Memoir no. 16, Geological Society of America, Washington, vol. 16, p. 33, pl. 21, figs. 8, 10, 13-16, 19.

***Cassidea* (*Semicassis*) *colongoi* Negri, 1934**

*Remarks*—This Paleogene fossil from Haifat, near Cufra, Fezzan, North Africa, is so poorly preserved that its placement in the correct genus is not possible. It could be a young *Cassis* or an immature *Phalium* (*Semicassis*).

*Synonymy*—

1934 *Cassidea* (*Semicassis*) *colongoi* Negri, Missione Scientifica Reale Accad. Italia a Cufra, Roma, vol. 3, p. 160, pl. 14, figs. 10 a-c (Haifat; Zella-Marada).

***Cassis conica* K. Martin, 1881**

*Range*—Tertiary of East Java, Indonesia.

*Remarks*—I doubt if this species can be assigned to either the cassids or Tonnidae until additional and more complete specimens are found.

*Synonymy*—

1881 *Cassis conica* K. Martin, Samml. Geol. Reichs-mus. Leiden, series 1, vol. 1, p. 121, pl. 8, fig. 2 (Wirosari, East Java; Neogene).

***Cassis coronata* Deshayes, 1830**

*Remarks*—Originally described in the Encyclopédie Méthodique (Vers), vol. 2, pt. 1, p. 209, this species was properly transferred to *Cassidaria* [*Galeodea*] by Deshayes in 1835. It was illustrated again by Wrigley, 1934, pl. 17, figs. 36, 37, 38. The name is preoccupied by *Cassis coronata* Röding, 1798. According to the synonymy given by Wrigley, 1934, p. 127, the next available name would be *venatrix* "Edwards" R. B. Newton, 1891, but that name is nude. A new name is required.

***Cassis corrugata* Swainson, 1822**

*Remarks*—The description of this un-illustrated shell is too brief to determine which of the cassids from the Galapagos Islands it might be. It was described on p. 5 of the appendix to the Catalogue of Shells..... of Mrs. Bligh, London, 1822. On page 24, lot 367, the locality is given as South Seas. I agree with Emerson and Old, 1963 (American Museum Novitates, no. 2153, p. 16) that it should be considered a *species inquirenda*.

***Cassis corsicanus* Locard, 1877**

*Remarks*—Lack of details of the columella and outer lip make it difficult to assign this poorly preserved Tertiary cassid from Corsica to its proper genus.

*Synonymy*—

1877 *Cassis corsicanus* Locard, Annales Société d'Agriculture Hist. Nat. et Arts Utiles de Lyon, series 4, vol. 9, p. 64, pl. 4, figs. 3, 4 (Casabianda, Corsica).

***Cassis deshayesi* Bellardi, 1852**

*Remarks*—This is either a *Cassis* or a *Galeodea*.

*Synonymy*—

1852 *Cassis deshayesi* Bellardi, Mémoires Soc. Géologique de France, ser. 2, vol. 4, p. 223, pl. 14, figs. 2-4 (La Palarea, Nice, France); deshajesii [sic] 1855, Mém. Reale Accad. Sci. Torino, ser. 2, vol. 15, p. 183.

***Cassidaria dubia* Noetling, 1895**

*Remarks*—Vredenburg (1921, p. 269) claims this Burma fossil is a *Cymatium* belonging to the subgenus *Lampusia*. Noetling also named it *Semicassis protojaponica*.

*Synonymy*—

1895 *Cassidaria dubia* Noetling, Memoirs Geol. Survey India, vol. 27, p. 27, pl. 6, figs. 2, 3.  
1901 *Semicassis protojaponica* Noetling, Palaeontologica Indica, new series, vol. 1, pt. 3, p. 295, pl. 19, fig. 15 (Minbu).  
1921 *Tritonium* (*Lampusia*) *dubium* (Noetling), Records Geol. Survey India, vol. 51, pt. 3, pp. 269, 289 (Minbu, Burma; Oligocene).

***Cassis elegans* Grateloup, 1827**

*Remarks*—I have not seen this Miocene species, but from the original drawing I would suspect that it is a true *Cassis* and closely related to *mamillaris* Grateloup, 1827.

*Synonymy*—

1827 *Cassis elegans* Grateloup, Bull. d'Hist. Nat. Soc. Liméenne de Bordeaux, vol. 2, no. 7, p. 19 (Gaas Dax, Landes, France); 1840, Conchyl. Fossile Terr. Tert. . . . . l'Adour, Atlas, no. 32, *Cassis* pl. 1, fig. 1.

***Cassis eparcyensis* d'Archiac, 1843**

*Remarks*—This European Triassic gastropod is not a cassid, but possibly an *Orthostomia* Kittl, 1899. It was originally described in Mém. Soc. Geol. France, vol. 5, pt. 2, p. 385.

**Cassis fasciata Borson, 1825**

*Remarks*—This fossil is based upon a very poor figure and I cannot place it to genus. It is not *Cassidea fasciata* Bruguière, 1792, which is *Cassis tessellata* Gmelin, 1791, from West Africa. Sacco, 1890, pt. 7, p. 14, relates it to *Cassis mamillaris* Grateloup, 1827.

*Synonymy*—

1825 *Cassis fasciatus* Borson, *Memorie della Reale Accademia Scienze di Torino*, vol. 29, p. 309, fig. 29 (Astigiana).

**Cassis fuchsi Dreger, 1892**

*Remarks*—I am unable to place this poorly preserved European Tertiary cassid in any particular subgenus. Noszky (1940) described a variety and placed the species in *Galeodocassis*.

*Synonymy*—

1892 *Cassis fuchsi* Dreger, *Annalen des K. K. Naturhistorischen Hofmuseums, Wien*, vol. 7, p. 21, pl. 3, fig. 10 (Tertiary; Häring, Tirol).  
 ?1940 *Galeodocassis fuchsi* Dreger var. *saccoi* Noszky, *Annales Historico-Naturales Musei National Hungarici, pars Mineralogica*, Budapest, vol. 33, p. 17, pl. 1, fig. 20 (*sacconi* on plate explanation).

**Cassis gibba Risso, 1826**

*Remarks*—This 34 mm.-long, fossil from Magan, France, is unknown to me.

*Synonymy*—

1826 *Cassis gibba* Risso, *Histoire Naturelle. . . . . de L'Europe Méridionale*, vol. 4, p. 182.

**Cassis glans Röding, 1798**

*Remarks*—This is a synonym of the nassariid, *Demoulia abbreviata* Gmelin, 1791, from South Africa.

*Synonymy*—

1798 *Cassis glans* Röding, *Museum Boltenianum*, Hamburg, pt. 2, p. 31, no. 373; refers to *Conchyl.-Cab.*, vol. 10, figs. 1463, 1464.

**Cassis globulus Menke, 1829**

*Remarks*—This is a synonym of the nassariid, *Demoulia ventricosa* Lamarck (see Mörch, *Malak. Blatt.*, vol. 18, p. 126).

*Synonymy*—

1829 *Cassis globulus* Menke, *Verzeichniss Conchyl.-Sammlung Malsburg, Pyrmont*, p. 37, no. 807 (no locality). Non Röding, 1798.

**Cassis gracilenta Yokoyama, 1929**

*Remarks*—According to F. S. MacNeil, 1960, U. S. Geol. Survey Prof. Paper 339, p. 82, this species belongs to the nassariid genus *Cyllene* Gray.

*Synonymy*—

1929 *Cassis gracilenta* Yokoyama, *Imperial Geol. Survey Japan, Report 101*, p. 46, pl. 3, fig. 4 (Tertiary of Okinawa and Taiwan).

**Phalium granulosum Link, 1807**

*Remarks*—From the brief description of this one-inch long shell, I suspect it may be a *Semicassis*, possibly *granulatum* Born, 1778.

*Synonymy*—

1807 *Phalium granulosum* Link, *Beschreibung der Naturalien-Samml.*, pt. 4, p. 12 (no locality; no figure reference). Non Bruguière, 1792.

**Cassis gregorii Schlosser, 1925**

*Range*—Eocene of the Alps

*Remarks*—This is a poorly preserved fragment of some kind of cassid. Schlosser allied it to *thesei* Brongniart, 1823, and it may be a synonym of it.

*Synonymy*—

1925 *Cassis gregorii* Schlosser, *Abhandl. Bayerische Akademie Wissen. München*, vol. 30, p. 111, pl. 4, fig. 4.

**Cassis (Phalium) guppyana Maury, 1912**

*Remarks*—This is so poorly preserved and so badly illustrated that I doubt if it will ever be placed in its correct genus.

*Synonymy*—

1912 *Cassis (Phalium) guppyana* Maury, *Jour. Acad. Nat. Sciences Philadelphia*, vol. 15, p. 84, pl. 12, figs. 5, 6 (bed no. 8, Soldado Rock, Gulf of Paria, Trinidad, Eocene).

**Cassis guttata Röding, 1798**

*Remarks*—This is a *nomen nudum*.

*Synonymy*—

1798 *Cassis guttata* Röding, *Museum Boltenianum*, Hamburg, pt. 2, p. 30, no. 366.

**Buccinum ignave "Solander" Dillwyn, 1817**

*Remarks*—This is a nude name introduced by Dillwyn in the synonymy of *Buccinum [Phalium] saburon*. It evidently was a manu-

script name for an immature specimen, according to Dillwyn who published it in his Descriptive Catalogue of Shells, vol. 2, p. 594.

**Cassis (Semicassis) inarimensis Bellini, 1900**

*Remarks*—This Tertiary Italian shell is too poorly described and figured to assign it properly. It looks like an elongate *Tylocassis*.

*Synonymy*—

1900 *Cassis (Semicassis) inarimensis* Bellini, Bollettino della Soc. Zoologica Italiana, ser. 2, vol. 1, p. 151, fig. 1.

**Semicassis indicus Douvillé, 1929**

*Remarks*—This poorly preserved, fragmentary specimen may be related or synonymous with other Lower Eocene Indian cassids, such as *Phalium (Xenophalium) gradiferum*.

*Synonymy*—

1929 *Semicassis indicus* Douvillé, Memoirs Geol. Survey of India, Palaeontologia Indica, new ser., vol. 10, no. 3, p. 45, pl. 8, fig. 22 (Jakmari, Sind, India).

**Cassis inermis Beyrich, 1848**

*Remarks*—This is a nude name which was subsequently put into the synonymy of *Cassis megapolitana* Beyrich by Beyrich himself in 1854 (Die Conchylien des norddeutschen Tertiärgeländes, Berlin, pt. 2, p. 154).

**Cassis interrupta Risso, 1826**

*Remarks*—This 38 mm.-long, fossil European cassid is unknown to me. It was not illustrated.

*Synonymy*—

1826 *Cassis interrupta* Risso, Histoire Naturelle. . . . . de L'Europe Méridionale, vol. 4, p. 181 (Regions coralligènes. App. Eté).

**Phalium kanmonensis Hirayama, 1956**

*Remarks*—This species is based upon poorly preserved material, and it may well be a member of the family Tonnidae or a *Semicassis*.

*Synonymy*—

1956 *Phalium kanmonensis* Hirayama, Science Reports Tokyo Kyoiku Daig. sect. C. vol. 5, no. 45, p. 121, pl. 8, figs. 10, 11 (Upper Oligocene; Watase Ifikoshima, Yamaguchi-ken, Kyushu, Japan).  
1960 *Semicassis kanmonensis* (Hirayama), Oyama, Mizuno and Sakamoto, Illustrated Handbook of Japanese Paleogene Molluscs, p. 55, pl. 6, fig. 11.

**Cassis labrosa Deshayes, 1844**

*Remarks*—*Cassis labrosa* "Martini" is an invalid name. Deshayes put it in the synonymy of *Quimalea pomum* Linné (Deshayes, 1844, Anim. sans Vert., ed. 2, vol. 10, p. 143).

**Cassis (Semicassis) lagenaeformis Boettger, 1883**

*Range*—Middle Miocene of Nias Id., Indonesia.

*Remarks*—This species is founded upon a poorly preserved shell and may, indeed, be an internal mold. There are few diagnostic features that would even justify assigning it to *Phalium* or *Semicassis*.

*Synonymy*—

1883 *Cassis (Semicassis) lagenaeformis* Boettger, Jarrboek van het Mijnwegen in Nederl. Oost-Indië, vol. 12, p. 192, pl. 8, figs. 5a-c (Middle Miocene, Nias Id.); 1915, Zwierzycki, loc. cit., Verhandelingen for 1913, p. 105 (Kroë, Benkoelen, Sumatra).

**Cassis latissima Rigacci, 1866**

*Remarks*—This is evidently a museum label name and a *nomen nudum* added to Cat. Conch. Collezione Rigacci, Rome, p. 44, no. 4312 (America). It could be a *Cassis tuberosa* (Linné) with a broad parietal shield.

**Cassis lineata H. Karsten, 1849**

*Remarks*—This is a ½-inch-long fossil cassid of unknown locality. Although it is probably a young *Phalium*, the description is not detailed enough to assign it to its probable genus. I am indebted to Dr. Harald A. Rehder for supplying the original publication that was not available to me.

*Synonymy*—

1849 *Cassis lineata* H. Karsten, Verzeichniss der im Rostocker Acad. Mus. Versteinerungen Sternberger Gestein, Rostock, p. 30 (no. figs.; no locality).

**Cassis malleata Mörch, 1850**

*Remarks*—This is a nude name proposed by Mörch in his Catalogus Conchyliorum Kierulf, Hafniae, 1850, p. 13, no. 315 (Antilles), and is probably a *Tylocassis*.

**Cassis? (Mangkalia) martini Beets, 1941**

*Range*—Upper Miocene of Mangkal, East Borneo, Indonesia.

*Remarks*—This species and genus were based upon very incomplete fragments. The holotype is represented by the spire of what appears to be



a *Cassis* (s.s.) or possibly a *Cypraeacassis*, although other families, such as the Fascioliidae and Strombidae should not be overlooked. Until more complete specimens are found, little can be done in assigning either of these taxa to their proper place.

#### *Synonymy*—

- 1941 *Cassis?* (*Mangalia*) *martini* Beets, Verhandeligen Geologisch Mijnbouw Genoots, Nederland en Kolon., vol. 13, p. 87, pl. 5, figs. 187-192 (no locality).

#### **Cassidea menkarae Cuvillier, 1933**

*Remarks*—I cannot place this extremely poorly preserved Egyptian Oligocene specimen in its proper genus.

#### *Synonymy*—

- 1933 *Cassidea menkarae* Cuvillier, Mémoires l'Institut d'Egypte, new series, vol. 22, p. 49, pl. 6, figs. 7, 8 (Bortonien, 1 km. south of the third pyramid of Giza, Egypt).

#### **Cassis mississippiensis Conrad, 1847**

*Remarks*—This is a *Galeodea* from the Oligocene of Mississippi.

#### *Synonymy*—

- 1847 *Cassis mississippiensis* Conrad, Proc. Acad. Nat. Sci. Philadelphia, vol. 3, pt. 11, p. 288 (Vicksburg, Miss.).

#### **Cassis nilotica Bellardi, 1854**

*Remarks*—This fossil fragment from the Tertiary of Italy is probably a true *Cassis*, but the species will probably remain dubious until more specimens are obtained. It resembles *caucellata* Lamarck. Oppenheim (1906, Palaeontographica, vol. 30, p. 306) claims that *Cassis tricarinata* Schafhäütl is a synonym.

#### *Synonymy*—

- 1854 *Cassis nilotica* Bellardi, Memorie delle Reale Accademia della Scienze di Torino, series 2, vol. 15, p. 183, pl. 2, fig. 1 (Egitto, Italy).  
1863 *Cassis tricarinata* Schafhäütl, Süd-Bayerns Lethaea Geognostica, Leipzig, pl. 49, fig. 3 (not seen); 1867. O. Fraas, Aus dem Orient (Geologische Beobachtungen), Stuttgart, p. 146.

#### **Cassis nodulifera Partsch, 1837**

*Remarks*—This is evidently a *nomen nudum* and a manuscript name. I can find no record of its having been described.

#### *Synonymy*—

- 1837 *Cassis nodulifera* Partsch, Bronn, Neues Jahrbuch für Mineralogie, Geog. Geol. und Petrefak., Stuttgart, for 1837, p. 417, no. 45 (nude name); 1848, Hoernes, Verz. Fossil-Reste Wien, p. 18 (nude name).

#### **Cassis orbiculata Hoeninghaus, 1831**

*Remarks*—This is evidently a *nomen nudum*. It is not *Cassidaria orbiculata* Risso, 1826, p. 185.

#### *Synonymy*—

- 1831 *Cassis orbiculata* Hoeninghaus, Neues Jahrbuch für Mineralogie, Geog. Geol. und Petrefak., Stuttgart, for 1831, p. 146 (nude name).

#### **Cassidea (Semicassis) ormarensis Vredenburg, 1925**

*Remarks*—This Tertiary gastropod from the nodular shales of Ormara, India, is so poorly preserved that I hesitate to judge whether it is a cassid or a *Tonna* (Memoirs Geol. Survey of India, vol. 50, pt. 1, p. 269, pl. 10, fig. 4).

#### **Phallium peckhamioides Ozaki, 1956**

*Remarks*—Due to Ozaki's misspelling of the genus *Pallium*, this bivalve was listed erroneously among the cassids in the Zoological Record, vol. 94, section 9.

#### **Cassis phillipsi d'Archiac and Haime, 1854**

*Range*—Eocene-Miocene, Gáj of Sind, India.

*Remarks*—The mold of this shell is so lacking in characters that it is almost impossible to assign it to any cassid genus. It may be an immature specimen of "*Cassis*" *subharpaeformis* d'Archiac and Haime, 1854, from the same locality.

#### *Synonymy*—

- 1854 *Cassis phillipsi* d'Archiac and Haime, Descr. des Anim. Fossiles Group Nummulitique de l'Inde, Paris, p. 318, pl. 31, figs. 5, 5a (de la chaîne d'Hala [30 mi. n. of Hyderabad, Sind, India]).

#### **Buccinum plicatum Linné, 1758**

*Remarks*—This is a *species inquirenda*. A full discussion of this discarded name appears in the section on *Phallium fimbria* Gmelin.

#### **Cassidea plicata G. Fischer, 1807**

*Remarks*—The very brief, generalized description, without reference to a figure, does not make it possible to identify this species which G. Fischer allied to *Phallium saburon*.

*Synonymy*—

1807 *Cassidea plicata* G. Fischer, Muséum Demidoff, Moscow, vol. 3, p. 185, no. 15 (no locality).

*Semicassis protojaponica* Noetling, 1901

*Remarks*—This is a second name given to *Cassidaria dubia* Noetling, 1895. See above under *dubia*.

*Brugnonia pulchella* Jeffreys, 1883

*Remarks*—A year after describing this new genus and species, Jeffreys published a note stating that this very small snail might be the larval form of *Cassis sulcosa* (*Phalium granulatum* subspecies *undulatum* Gmelin) from the Mediterranean. Were this true, *Tylocassis* of Woodring, 1928, would be a synonym of *Brugnonia* Jeffreys. However, the fact that “the last or body-whorl is disproportionately large and takes up about three fourths of the shell” certainly excludes this from the cassid family. At present, I think it wise to consider the genus and species as indeterminate.

*Synonymy*—

1883 *Brugnonia pulchella* Jeffreys, Annals and Magazine of Nat. Hist., series 5, vol. 11, p. 398, 399, pl. 16, fig. 7; 1884, *ibid.*, vol. 12, p. 67.

*Cassis pullus* Röding, 1798

*Remarks*—This is a *Nassarius*.

*Synonymy*—

1798 *Cassis pullus* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 28, no. 347; refers to Conchyl.-Cab., vol. 2, fig. 413; Knorr, pt. 6, pl. 22, fig. 5.

*Cassidea punctata* G. Fischer, 1807

*Remarks*—The brief, generalized description, without a figure reference, makes it difficult to recognize this species. I have seen a small specimen of *Casuarina erinaceus* (Linné) in the Zoological Museum in Copenhagen bearing this name. I consider it a *nomen oblitum* and a *species inquirenda*.

*Synonymy*—

1807 *Cassidea punctata* G. Fischer, Muséum Demidoff, Moscow, vol. 3, p. 185, no. 14 (no locality).

*Cassis pygmaea* Muenster, 1835

*Remarks*—This is a nude name.

*Synonymy*—

1835 *Cassis pygmaea* Muenster, Neues Jahrbuch für Mineral., Geog., Geol. Petr., Stuttgart, p. 450.

*Cassidea pyramidata* Cuvillier, 1933

*Remarks*—I cannot place this poorly preserved, Egyptian Oligocene species in its proper genus.

*Synonymy*—

1933 *Cassidea pyramidata* Cuvillier, Mémoires l'Institut d'Egypte, new series, vol. 22, p. 48, pl. 8, figs. 16, 18, 19, 21 (Bortonien, 1 km. south of the third pyramid of Giza, Egypt).

*Cassis ringens* Swainson, 1822

*Remarks*—This well-known species belongs to the family Tonnidae, genus *Malea* Valenciennes. See Emerson and Old, 1963, American Museum Novitates, no. 2153, p. 11, for a complete synonymy.

*Synonymy*—

1822 *Cassis ringens* Swainson, A Catalogue of the shells . . . . . Bligh Collection. . . . ., London, p. 7, no. 41, p. 25, no. 393, Appendix, p. 4 (no locality).

*Cassis rotundata* Defrance, 1817

*Remarks*—I have not seen this fossil Italian species, and from the description I cannot place it to genus.

*Synonymy*—

1817 *Cassis rotundata* Defrance, Dictionnaires Sci. Naturelles, Paris, vol. 7, p. 211, no. fig. (Plaisantin, Italy).

*Cassis saussurea* Risso, 1826

*Remarks*—This 38 mm.-long, fossil European cassid is unknown to me. It may be close to *Phalium laevigatum* Defrance, 1817.

*Synonymy*—

1826 *Cassis saussurea* Risso, Histoire Naturelle. . . . de L'Europe Méridionale, vol. 4, p. 182, pl. 6, fig. 83 (Terrains argileux de Magnan).

*Cassisoma semielegans* Rovereto, 1900

*Remarks*—I am unable to place this poorly preserved species in its correct genus, but am inclined to agree with Sacco (1904, p. 98) that it is probably an *Echinophoria*.

*Synonymy*—

- 1900 *Cassidoma* (*Echinophoria*) *semielegans* Rovereto, Illus. Moll. Foss. Tongr., p. 163, pl. 9, fig. 1 (Italian Tertiary).  
 1904 *Cassidea* (*Echinophoria*) *semielegans* Rovereto, Sacco, 1 Molluschi Terr. Terz. Piemonte & Liguria, pt. 30, p. 98, pl. 21, fig. 1 (Tongriano: Mioglia).

*Cassis* (*Semicassis*) *shubutensis* Aldrich, 1885

*Remarks*—This Eocene Mississippi and Mexico cassid is probably a *Galeodea* according to Gardner, 1939, p. 22. She allies it to *Galeodea* (*Galeodaria*) *petersoni* Conrad.

*Synonymy*—

- 1885 *Cassis* (*Semicassis*) *shubutensis* Aldrich, Journal Cincinnati Society Natural History, vol. 8, p. 147, pl. 2, figs. 5a, b (Shubuta, Miss., and Red Bluff; Eocene); 1886, Alabama Geological Survey Bull. 1, p. 33, pl. 2, figs. 5a, b.  
 1939 *Galeodea*? (*Galeodaria*) *shubutensis* (Aldrich), Gardner, U.S. Geol. Survey Professional Paper 193-B, p. 22.

*Cassis togatus soldadensis* Maury, 1912

*Remarks*—According to Rutsch, 1943, p. 177, this Eocene Trinidad fossil is a *Harpa* of the subgenus *Eocithara*. *Cassis togata* White, 1887, originally described as a *Strombus*, is probably a *Harpa*.

*Synonymy*—

- 1912 *Cassis togata* var. *soldadensis* Maury, Jour. Acad. Nat. Sci., Philadelphia, vol. 15, p. 86, pl. 12, fig. 7 (Soldado Rock, Gulf of Paria, Trinidad; Eocene).

*Cassis striolata* Risso, 1826

*Remarks*—This 46 mm.-long, fossil European cassid is unknown to me. It was not illustrated.

*Synonymy*—

- 1826 *Cassis striolata* Risso, Histoire Naturelle. . . . . de L'Europe Méridionale, vol. 4, p. 182 (la Trinité).

*Semicassis subgranosa* Tate, 1889

(Pl. 16)

*Range*—Tertiary of Yorke's Peninsula, Australia

*Remarks*—This 55-mm.-long cassid is evidently an immature specimen, and I cannot place it with confidence in either *Phalium* or *Echinophoria*. It has a superficial resemblance to the Recent *Phalium semigranosum* (Lamarck).

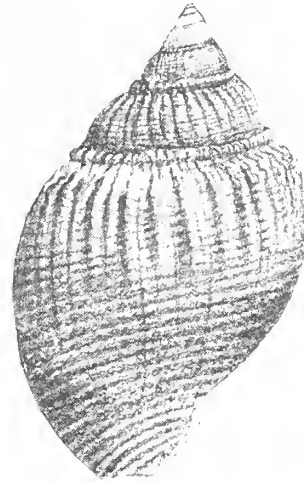


Plate 16. Type of *Semicassis subgranosa* Tate, 1889, from the Tertiary of Yorke's Peninsula, Australia. Length: 55 mm.

*Synonymy*—

- 1889 *Semicassis subgranosa* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 166, pl. 7, fig. 10 (hard craggy-limestones, Edithburgh, Yorke's Peninsula).

*Cassis subharpaeformis* d'Archiac and Haime, 1854

*Range*—Eocene-Miocene, Gáj of Sind, India.

*Remarks*—It would be difficult to assign this poorly preserved specimen to any of the genera of cassids.

*Synonymy*—

- 1854 *Cassis subharpaeformis* d'Archiac and Haime, Descr. des Anim. Fossiles Group Nummulitique de l'Inde, Paris, p. 317, pl. 31, fig. 6 (de la chaîne d'Hala, [30 mi. n. of Hyderabad, Sind, India]). Non Sacco, 1890.

*Cassis subintermedia* Orbigny, 1852

*Remarks*—This name was applied to Grateloup's very poor figure in his supplemental *Cassis* plate 1, fig. 7. It is possibly a *Galeodonsia*. Orbigny's date of 1847 is evidently a manuscript date. Cossmann and Peyrot (1924, Actes Soc. Linn. Bordeaux, vol. 75, p. 84, pl. 11, figs. 40-41) illustrate quite another species, and possibly a *Eudolium*, under this name.

*Synonymy*—

- 1840 *Cassis intermedia* Grateloup, Conchyliologie Fossile Terrains Tert. . . . . l'Adour, vol. 1, atlas, pl. 46, fig. 7 (non Brocchi, 1814).  
 1852 *Cassis subintermedia* Orbigny, Prodrome Paléontologie Stratigraph. Universelle, Paris, vol. 3, p. 90, no. 1671. Refers to Grateloup, pl. 46, fig. 7. Dax, St.-Paul.



**Cassis sublaevigaster d'Archiac and Haime, 1854**

*Range*—Eocene-Miocene, Gáj of Sind, India.

*Remarks*—The mold of this shell is so lacking in characters that it is almost impossible to assign it to any cassid genus.

*Synonymy*—

- 1854 *Cassis sublaevigaster* d'Archiac and Haime, Descrip. des Anim. Fossiles Group Nummulitique de l'Inde, Paris, p. 318, pl. 31, fig. 4 (de la chaîne d'Hala [30 mi. n. of Hyderabad, Sind, India]).

**Cassis sulcata Risso, 1826**

*Remarks*—This 40 mm.-long, fossil European cassid is unknown to me. It is not *Phalintum sulcatum* Link, 1807. Meuschen's 1787 name, *Cassis sulcata*, is non-binomial.

*Synonymy*—

- 1826 *Cassis sulcata* Risso, Histoire Naturelle. . . . de L'Europe Méridionale, vol. 4, p. 181 (la Trinité).

**Cassis tongriana Sacco, 1890**

*Remarks*—This is an immature and poorly preserved specimen which Sacco originally placed in the subgenus *Casmaria*. He later placed it in *Galeodocassis*. The species is unknown to me, and its placement is doubtful.

*Synonymy*—

- 1890 *Cassis (Casmaria) tongriana* Sacco, I. Moll. Terreni Terziarii Piemonte, pt. 7, p. 26, pl. 1, fig. 22 (Tongriano: Oligocene; Carcare, Dego).  
 1900 *Cassisoma (Galeodocassis) tongriana* Sacco, Rovereto, Illustrazione dei Moll. Fossili Tongriani, p. 162.  
 1904 *Galeodocassis? tongriana* Sacco, Sacco, loc. cit, pt. 30, p. 96.

**Galeodea trituberculoides Kanno, 1958**

*Range*—Upper Oligocene of central Japan.

*Remarks*—Unfortunately, the unique holotype lacks the lower part of the columella and the siphonal canal. For this reason, I hesitate to assign this species to a genus or subgenus. It is probably a *Phalintum*, and to judge from the sculpture, I am inclined to place it in the subgenus

*Maviccassis*, rather than the subgenus *Echinophoria* to which Weaver's *trituberculata* belongs.

*Synonymy*—

- 1958 *Galeodea trituberculoides* Kanno, Sci. Reports Tokyo Bunrika Daigaku, geol. series, C 6, no. 55, p. 212, pl. 6, fig. 20 (Nenokami sandstone, Upper Oligocene, Hikokubo, Yoshidamachi, Saitama Pref., central Japan).

**Cassis tuberculosa Röding, 1798**

*Remarks*—Röding referred to figure 11 on Favanne's plate 26, but this must be a misprint, since all figures in Favanne's edition of "La Conchyliologie" bear letters. There are several species on plate 26 which are warty or tuberculate. I am considering Röding's name as dubious.

*Synonymy*—

- 1798 *Cassis tuberculosa* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 29, no. 354. Refers to Favanne, pl. 26, fig. 11 [sic].

**Cassidea (Semicassis) umbgrovei**

**K. Martin, 1931**

*Range*—Upper Eocene, Nanggoelan beds of Java, Indonesia.

*Remarks*—I have not examined the type, and I cannot decide from the poor illustration nor from the description whether this is a cassid or a member of the Tonnidae.

*Synonymy*—

- 1931 *Cassidea (Semicassis) umbgrovei* K. Martin, Wetenschap. Mededeel., no. 18, Dienst. Mijnbouw Nederlandsch-Indië, p. 33, pl. 5, fig. 3 (Kali Puru, Nanggoelan beds, Java; Upper Eocene).

**Cassis zirpoloi Negri, 1934**

*Remarks*—This is a very poorly preserved Paleogene fossil from North Africa, and I suspect it may be a *Tonna*.

*Synonymy*—

- 1934 *Cassis zirpoloi* Negri, Missione Scientifica Reale Accad. Italia a Cufra, Roma, vol. 3, p. 160, pl. 14, figs. 10 a-c (Haifat, Fessan, North Africa).

### Selected Bibliography

The majority of the bibliographic references to Cassidae appears in the synonymies under the various species. For this reason, the standard iconographs by Reeve, Kiener, Tryon, and others do not appear here.

- Anderson, D. T. 1966. Further observations on the life histories of littoral gastropods [*Xenogalca labiata* eggs] in New South Wales. Proc. Linn. Soc. New South Wales, vol. 90, pt. 3, no. 409, pp. 243-251, pl. 10.
- Anonymous. 1961. *Cassis cornuta* (Helmet Shell) egg cluster. Hawaiian Shell News, vol. 9, no. 12, p. 1, fig. (=Cymatidae).
- Argüelles, R. P. Tomas. 1909. *Cassis saburon* Bruguière, 1789—Notas Malacológicas. Boletín Sociedad Aragonesa Ciencias Naturales, Zaragoza, vol. 8, no. 2, pp. 41-44.
- Bayer, Charles. 1935. Catalogue of the Cassididae in the Rijksmuseum van Natuurlijke Historie. Zoologische Mededeelingen, vol. 18, pp. 93-120, 2 figs.
- Bayer, Charles. 1936. Sur une difformité du *Cassis cornuta* (L.), causée par des Balanes. Mem. Musée Royal d'Histoire Naturelle de Belgique, 2nd ser., fasc. 3, pp. 41-42, figs. 1, 2.
- Beets, C. 1943. Die Gattung *Galeodea* Link im Tertiär von Insulinde. Verh. Geol. Mijnbouw Gen. Geol. Serie, vol. 13, pp. 435-443, 9 figs.
- Chari, V. 1956. The Horned Helmet *Cassis cornuta* Linn.—An addition to the list of marine gastropods of Bombay. Journ. Bombay Natural History Society, vol. 53, pp. 736-737, 1 fig.
- Clench, W. J. and R. T. Abbott. 1943. The Genera *Cyprae-cassis*, *Morum*, *Sconsia* and *Dalium* in the Western Atlantic. Johnsonia, vol. 1, no. 9, pp. 1-8, 4 pls.
- Clench, W. J. 1944. The Genera *Casmaria*, *Galeodea*, *Phalium* and *Cassis* in the Western Atlantic. Johnsonia, vol. 1, no. 16, pp. 1-16, pl. 1-8.
- Cornman, Ivor. 1963. Toxic properties of the saliva of *Cassis*. Nature, vol. 200, no. 4901, pp. 88-89.
- Cossmann, M. 1903. Cassididae. Essais de Paleoconchologie Comparée, Paris, vol. 5, pp. 119-135.
- Cotton, B. C. 1945. Southern Australian Gastropoda, Part 2, Doliacea. Trans. Royal Soc. South Australia, vol. 69, no. 2, pp. 249-262, text figs.
- Cotton, B. C. 1954. No. 4: Family Cassididae. Royal Society of South Australia, Malacological Section. 4 pp. [1st edition with new species].
- Cotton, B. C. 1961. No. 4: Family Cassididae. Royal Society of South Australia, Malacological Section. 7 pp. [2nd enlarged edition].
- Coulon, L. 1937. Famille des Cassididées du Musée d'Elbeuf. Bull. Soc. d'Etude Sciences Nat. d'Elbeuf, vol. 55, pp. 61-72.
- Cross, E. R. 1967. Helmet Shell Chowder. Hawaiian Shell News, May 1967, vol. 15, no. 5, p. 7.
- Durham, J. W. 1942. Notes on Pacific coast Galeodeas. Jour. Paleontology, Wisconsin, vol. 16, no. 2, pp. 183-191, pls. 29, 30.
- Dall, W. H. 1909. The Miocene of Astoria and Coos Bay, Oregon. U.S. Geol. Survey, Professional Paper 59, pp. 57-69.
- Emerson, W. K. and W. E. Old, Jr. 1963. Remarks on *Cassis* (*Casmaria*) *vibexmexicana*. Nautilus, vol. 76, no. 4, pp. 143-145, pl. 10.
- Erlanger, R. von. 1893. Ueber einiger abnorme Erscheinungen in der Entwicklung der *Cassidaria echinophora*. Zool. Anzeiger, vol. 16, pp. 1-6, figs. [Abstract in Jour. Royal Microscopic Soc., 1893, pp. 163, 164] and the Conchologist, 1893, vol. 2, p. 121.
- Flores, Celestino. 1966. La familia Cassididae en las costas nororientales de Venezuela. Bol. Inst. Oceanog. Univ. Oriente, vol. 5, pp. 7-37.
- Fontes, Elena Martinez. 1966. "*Phalium* (S.) *itheringi*" Carcelles frente a Puerto Quequén. Neotropica, vol. 12, no. 37, pp. 38-40.
- Foster, Richard W. 1947. *Cassis tuberosa* L. feeding on an Echinoid (*Clypeaster rosaceus* L.). Nautilus, Philadelphia, vol. 61, no. 1, pp. 35-36.
- Gardner, Julia A. 1937. Relationships of the Tertiary Ficidae and Cassididae of the Western Gulf of Mexico (abstract). Proc. Soc. America, Washington, D.C. (1936), p. 72.
- Gardner, Julia A. 1939. Notes on fossils from the Eocene of the Gulf Province. II. The gastropod families Cassididae, Ficidae and Buccinidae. U.S. Geol. Survey Prof. Paper 193-B, pp. 21-44.
- Hedley, Charles. 1923. Notes on some Australian *Cassis*. Records Australian Museum, Sydney, vol. 14, no. 1, pp. 46-48, pl. 8.
- Iredale, Tom. 1914. Description of a new species of *Cassidea*. Proceedings Malacological Soc. London, vol. 11, p. 179-180, 1 text fig. [*C. royana*].
- Iredale, Tom. 1927. A review of Australian helmet shells (family Cassididae—phylum Mollusca). Records Australian Museum, Sydney, vol. 15, no. 6, pp. 321-354, pls. 31, 32.
- Jaume, M. L. 1944. *Casmaria atlantica* en Cuba. Rev. Soc. Malacol. Habana, vol. 2, no. 2, p. 70.
- Kenyon, Agnes F. 1904. Note on *Cassis paucirugis* Menke. Journal of Conchology, London, vol. 11, no. 1, pp. 12-13.
- Kobelt, W. 1876. Catalog der Gattung *Cassis* Lamarck. Jahrbücher der Deutschen Malakozool. Gesellschaft, vol. 3, pp. 77-82.
- Lewis, E. 1837. Objection to Mr. Stutchbury's Genus *Cyprae-cassis*. Mag. Nat. Hist. (Charlesworth, ed.); new series, vol. 1, p. 387-388.
- Lyman, Frank B. 1937. Food of *Cassis madagascariensis*. Nautilus, Philadelphia, vol. 51, no. 1, p. 34.
- Melville, James Cosmo. 1905. The subgenus *Casmaria* H. and A. Adams of *Cassis* Lamarck. Journal of Conchology, vol. 11, no. 5, pp. 176-178.
- Moore, D. R. 1956. Observations of predation on echinoderms by three species of Cassididae. Nautilus, Philadelphia, vol. 69, no. 3, pp. 73-76.
- Moore, Ellen James. 1963. Miocene Marine Mollusks from the Astoria Formation in Oregon. Geol. Surv. Prof. Papers 419, pp. 1-109, 32 pls.
- Paul, W. J. 1952. Varices on Cassids. Bulletin no. 8, Auckland Museum Conchology Club, p. 10.
- Pilsbry, H. A. and T. L. McGinty. 1939. Small Cassididae of Florida and the West Indies. Nautilus, Philadelphia, vol. 52, no. 3, pp. 73-77, pl. 5.
- Powell, A. W. B. 1928. The Recent and Tertiary Cassids of New Zealand and a study in hybridization. Trans. New Zealand Institute, vol. 59, pp. 629-642, pl. 74-76.
- Reynell, A. 1905. Some Account of the anatomy of *Cassidaria rugosa* (Linn.). Proc. Mal. Soc. London, vol. 6, pp. 292-299, pl. 15.

- Rutsch, R. 1931. Zur Nomenklatur und Systematischen Stellung einiger Tertiärer Cassididae au New-Seeland. *Eclogae Geologicae Helvetiae*, vol. 24, no. 2, pp. 251-253, figs. a, b.
- Salmon, Ed. 1948. Catalogue des Cassididés, Doliidés et Pirudilés du Muséum, avec description d'une espèce et d'une variété nouvelles. *Journ. de Conchyl.*, Paris, vol. 88, no. 4, pp. 158-166, 2 figs.
- Schenck, Hubert G. 1926. Cassididae of Western America. *Bull. Dept. Geol. Sci. University of California*, vol. 16, no. 4, pp. 69-98.
- Schroeder, R. E. 1962. Urchin Killer. *Sea Frontiers*, vol. 8, no. 3, pp. 156-160, 5 figs.
- Sowerby, G. B. 1837. Some observations on Mr. Stutchbury's proposed new genus of univalve shells, *Cypraecassis*. *Ann. Mag. Nat. Hist.*, new series, vol. 1, pp. 365-370, figs. 28a-c.
- Sowerby, G. B. 1837. Additional remarks on Mr. Stutchbury's proposed genus *Cypraecassis*. *Ann. Mag. Nat. Hist.*, new series, vol. 1, pp. 431, 432.
- Sowerby, G. B. 1896. Description of *Cassis adcocki*, a new species. *Proceedings Malacological Society London*, vol. 2, p. 14.
- Stutchbury, S. 1837. On *Cypraecassis*, a proposed new genus of univalve shells, for the reception of certain species of Bruguière's genus *Cassis*. *Ann. Mag. Nat. Hist.*, new series, vol. 1, pp. 214-217.
- Stutchbury, S. 1837. Additional remarks upon the proposed genus *Cypraecassis*. *Ann. Mag. Nat. Hist. (Charlesworth)*, new series, vol. 1, pp. 470-473.
- Thornley, G. 1954. Some Helmet shells (Cassididae) from my collection. *Proc. Zool. Soc. New South Wales*, 1952-53, pp. 33-55, 2 figs.
- Warren, T. P. 1951. Collecting Cassididae in the Leigh District [New Zealand]. *Bulletin no. 7, Auckland Museum Conchology Club*, pp. 4-5.
- Wolfe, Douglas A. 1967. *Cassis madagascariensis* and *C. m. spinella* offshore at Beaufort, North Carolina. *Nautilus*, vol. 81, no. 2, pp. 47-48.
- Wrigley, A. 1934. English Eocene and Oligocene Cassididae, with notes on the nomenclature and morphology of the family. *Proc. Malacological Soc. London*, vol. 21, no. 2, pp. 108-130, pls. 15-17.



### About the author

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both living and fossil. Dr. Abbott was a co-founder of the journals, *Johnsonia* and *Indo-Pacific Mollusca*, and has been editor of the latter since its beginning. He is author of numerous articles and books designed to assist amateurs. Dr. Abbott was born in Watertown, Massachusetts, on September 28, 1919, obtained his B.S. at Harvard College, his M.S. and Ph.D. at The George Washington University. He is married and has five children.



### Genus *Cassis* Scopoli, 1777

Type: *Cassis cornuta* (Linné, 1758)

The genus *Cassis* consists of seven Recent and about two dozen fossil species. They are characterized by large globular shells which have a broad parietal shield, a strongly upturned siphonal canal, and a thick outer lip bearing tubercles. The foot is broad and flat. The proboscis is retractible. A long, finger-like penis, with an open seminal groove running along its entire length, is located on the right side of the body of the male. The eyes are located at the base of the short tentacles. The horny operculum is proportionately very small and is oblong in shape. The radula ribbon is small and bears about 80 rows of delicate taenioglossate teeth. Each row contains seven teeth. *Cassis* feed mainly on sea urchins. The eggs of this genus are still unknown.

The seven living species are quite different in their characters and have been placed in three subgenera. The nuclear whorls vary considerably, but cannot be used as generic characters, since they bear no correlation with other features, and are in some cases identical to those found in other valid groups, such as *Phalium*, *Semicassis* and *Xenophalium*.

The genus first appeared in the Eocene in Indonesia and Europe. I have removed the subgenus *Morionella* Dall, 1909, from *Cassis* and allied it to *Galeodea* Link, 1807. The genus is absent in the Eastern Pacific and Mediterranean of today.

### Subgenus *Cassis* Scopoli, 1777

Type: *Cassis cornuta* (Linné, 1758)

The shells in this genus are large, sometimes reaching a length of 14 inches. The parietal shield is large, thick, and bounded on the left by a large, former varix. There are only five living species, one in the Indo-Pacific, one in West Africa, and three in the Caribbean. The radula formula is 4-1-4; 1-7; 3; 3 (the numbers referring to the denticles on the free ends of the teeth). The operculum is small, horny and oblong.

### Synonymy—

- 1772 *Cassida* Brünnich, Zoologiae Fundamenta, Copenhagen and Leipzig, p. 248 (in key only; no species mentioned). The date on the title page is 1771. Non *Cassida* Linné, 1758, an insect.  
 1777 *Cassis* "Klein" Scopoli, Introductio ad Historiam Naturalem, Prague, p. 393, no. 71; 1786, Deliciae florae et faunae. . . Austriaca, pt. 2, p. 76 (type by subsequent designation of Dall, 1909, p. 60: *C. cornuta* L.).  
 1789 *Cassidea* Bruguière, Encyclopédie Méthodique, vol. 1, pt. 1, p. xv; 1792, pt. 2, p. 414 (type by subsequent designation by Cossmann, 1903, p. 123: *Cassidea cornuta* (Linn.).  
 1798 *Cassis* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 28 (type hereby designated: *Buccinum cornutum* L., Gmel.).

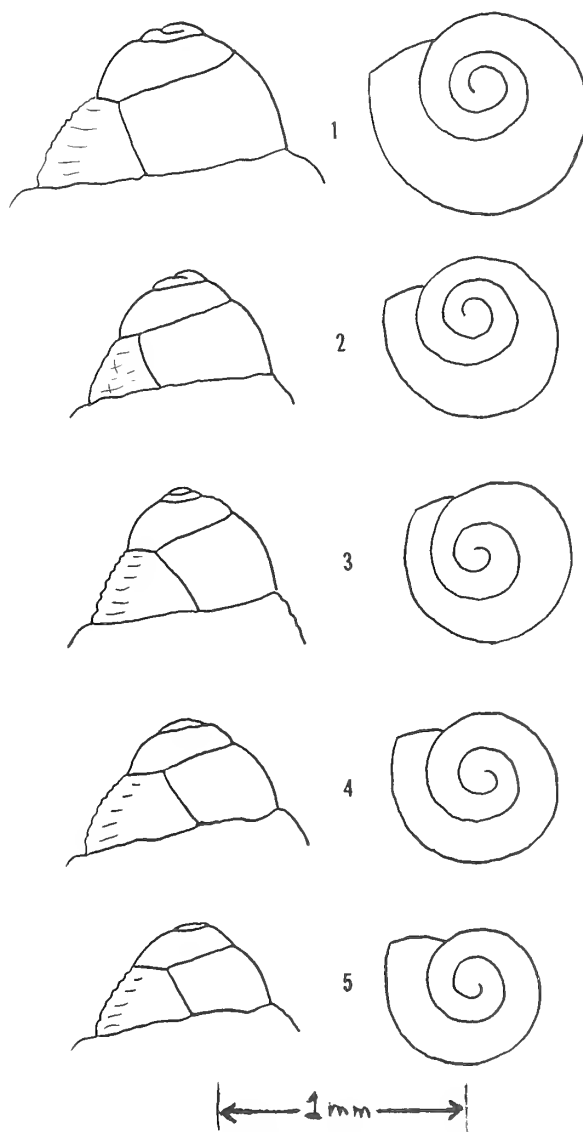


Plate 17. Nuclear whorls of *Cassis* (s.s.). Fig. 1, *cornuta* (Linné). Fig. 2, *tuberosa* (Linné). Fig. 3, *flammea* (Linné). Fig. 4, *madagascariensis* Lamarck. Fig. 5, *sulcifera* Sowerby.



- 1799 *Cassis* Lamarck, "Prodrome", Mem. Soc. Nat. Hist., Paris, vol. 1, p. 72 (type by monotypy: *Buccinum cornutum* L.).
- 1815 *Cassinia* Rafinesque, Analyse de la Nature, p. 45, (emendation for *Cassis* Scopoli). Misspelled *Cassinea* in Dodge, 1956, p. 177.
- 1857 *Goniogalca* Mörch, Catalogus Conchyliorum Suenson, Copenhagen, p. 21, no. 739; 1877, Mörch, Malakozool. Blätter, vol. 24, p. 37 (type by subsequent designation by Cossmann, 1903, p. 124: *C. madagascariensis* Lam.).
- 1882 *Fimbriola* "Megerle MSS" Scudder, Nomenclator Zoologicus, p. 138 (nomen nudum).
- 1890 *Galeodocassis* Sacco, I Moll. Terrenti Terzarii Piemonte Liguria, pt. 7, p. 18 (type by original designation: *G. anceps* Sacco, 1890 = *saccoi* Rovereto, 1900).
- 1899 *Cassisola* Rovereto, Atti. Soc. Ligustica (now Atti Soc. di Scienze e Lettere di Genova), vol. 10, p. 107. New name for *Cassis* Klein, 1753, a non-binomial name.

**Nomenclature**—The present day use of the name *Cassis* Scopoli did not come into general use until Dall's 1909 revision. Bruguière's genus *Cassidea*, which is now considered a synonym of *Cassis*, was used for various other groups, such as *Phalium*, *Cypraecassis* and *Casmaria*.

Dall was evidently the first to designate a type for *Cassis* Scopoli. Montfort's 1810 designation is for Lamarck's *Cassis*, and does not apply to Scopoli's genus, although the two names refer to the same genus.

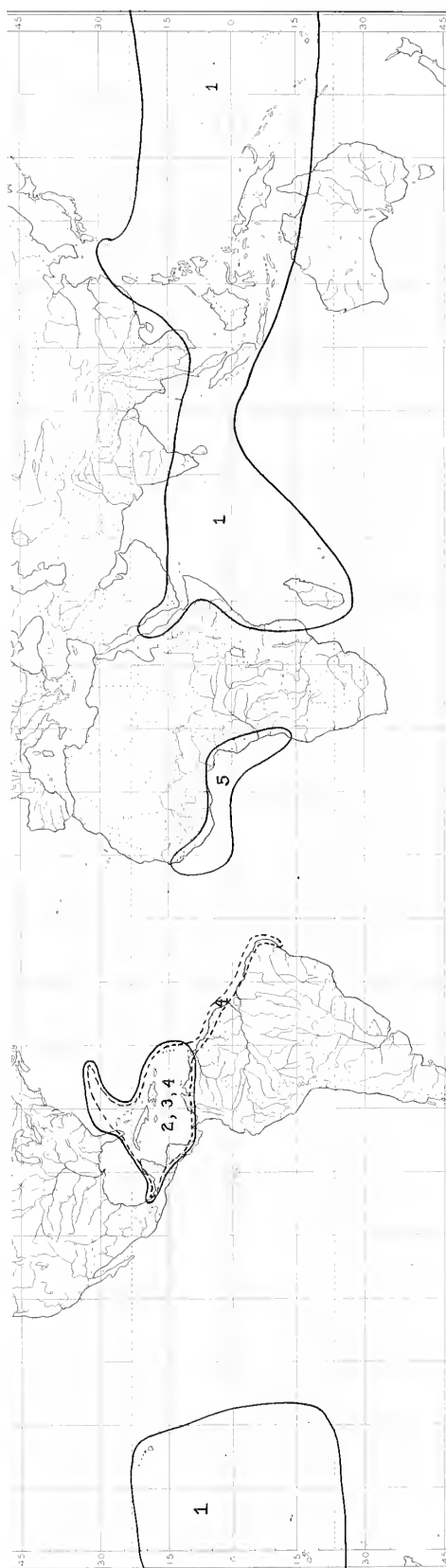


Plate 18. World distribution of Recent *Cassis* (*Cassis*). 1, *cornuta* (Linné); 2, *flammica* (Linné); 3, *madagascariensis* (Lamarck); 4, shown with a dotted line, *tuberosa* (Linné); 5, *tessellata* (Gmelin).

**Cassis cornuta (Linné, 1758)**

(Pl. 3, figs. 1-4)

*Range*—East Africa to Polynesia; Japan to Australia. Its distribution broadly coincides with that of coral reefs of the Indo-Pacific.

*Remarks*—The Horned Helmet is the largest and most widespread of the Indo-Pacific Cassidae. It reaches a length of 14 inches. It is characterized by its large, orange-yellow parietal shield, the row of 5 to 7 knobs on the shoulder of the dorsum, and by the numerous honeycomb-like pittings on the outer surface. Although the shells are variable in several characters, particularly in the coloration and shape of the parietal shield and in the size and number of knobs on the shoulder, I can recognize no consistent differences between Red Sea, East African and Polynesian specimens.

In some areas particularly Hawaii, there appears to be considerable sexual dimorphism in the shells, the males being smaller, less ovate, and having larger and fewer knobs on the dorsum. Young specimens have 9 to 13 small, uniform-sized knobs on the shoulder.

The shell is used by the natives of the South Seas as a container for liquids. It is a popular household shell ornament in many parts of the world, but does not lend itself to cameo carvings.

When shaking a cleaned specimen, one can sometimes hear a small, trapped object inside that defies release even though the shell is slowly rolled in a counterclockwise direction. This has led some shell collectors to suppose that a pearl or piece of broken shell was trapped inside by former varices. However, the object is usually a piece of coral, stone, or shell trapped inside the umbilical region and not within the apertural opening or cavities of the early whorls.

*Habitat*—*Cassis cornuta* Linné occurs in colonies at depths from 1 to 15 fathoms where the bottom consists of sand and broken coral rock. During periods of inactivity, or perhaps while feeding, they may be partially buried below the surface of the sand. They probably feed on echinoderms. Robert C. Guest (*in litt.*, 1968) reports that "they are more active at night, and when moving they lift their shells straight up, move forward, then drop their shells down."

*Description*—Adult shell large, 175 to 348 mm. (7 to 14 inches) in length, rotund, with a row of 5 to 7 large or small spines on the shoulder, with a large, oblong, heavy parietal shield, and with a heavy outer lip bearing 5 to 7 large whitish teeth on the central inner edge. Nuclear whorls 2-1/2, minute, bulimoid, opaque-white, smooth, and with a brown suture in the first whorl. Post-nuclear whorls with 5 to 7 irregular, poorly beaded spiral threads. The first varix is produced in the 7th or 8th whorl. Adults with 7 or 8 former varical lips in the spire. Body whorl with 3 or 4 spiral, raised ridges, the upper one on the shoulder bearing 5 to 7 long or short, pointed or broad knobs, while the 2 cords below each bear 3 or 4 very small knobs. There may be an additional low, spiral cord near the base. Outer surface of whorls minutely pitted. Parietal shield heavy, broadly or narrowly elongate, yellowish or brownish orange, with two spotted spiral cords and the surface pitting showing through the central region. Lower half of columella with 8 to 11 poorly developed, whitish, spiral plicae. Outer lip heavy, broad, glossy, cream to orange and with 5 to 7 large teeth on the inner edge in the central region. Posterior side of outer lip usually with 7 broad patches of brown. Umbilicus usually sealed; true umbilicus usually open and containing trapped pieces of loose coral, stones or pieces of shells. Siphonal canal fairly long and pointing upward.

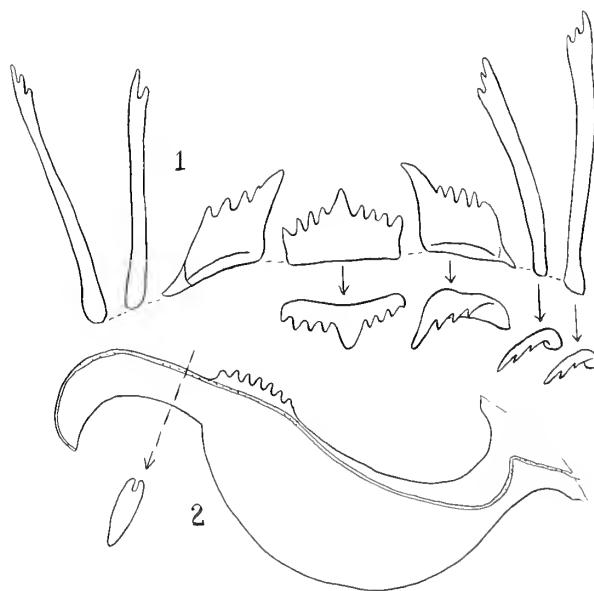


Plate 19. *Cassis cornuta* (Linné), adult male from Okinawa Island, Ryukyus. Fig. 1, row of seven radular teeth. Fig. 2, penis, 120 mm. in length, showing open seminal groove in cross-section.

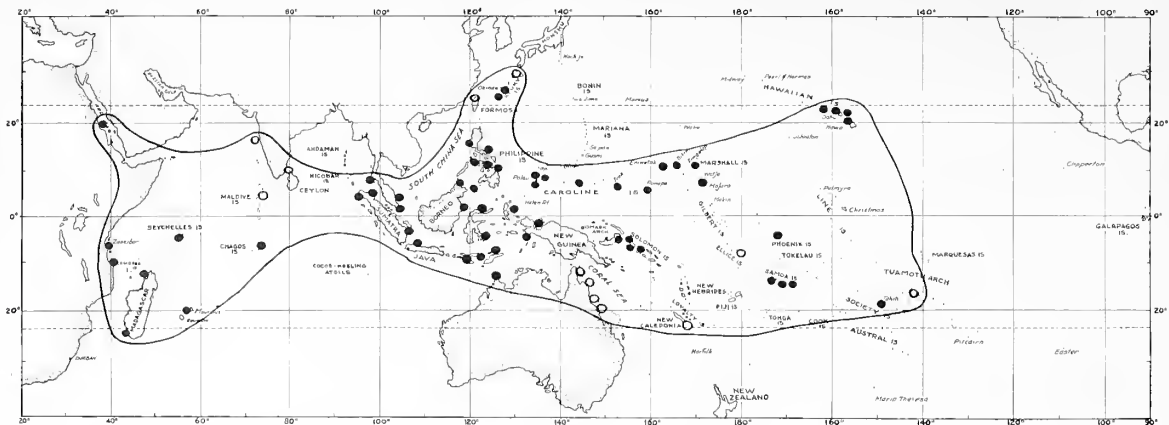


Plate 20. Geographical distribution of *Cassis cornuta* (Linné). Open circles are literature records.

In young specimens less than 60 mm. in length: inner columella with about 14 small, short, spiral plicae; inside of outer lip with 10 to 12 small denticles along the entire length of the outer lip; body whorl maculated with brown and with cancellate sculpturing in which the axial ribs predominate.

Operculum chitinous, brown, elongate-oblong and about  $\frac{1}{4}$  the length of the aperture.

#### Measurements (mm.)—

length	width	no. whorl	no. varices	
312.0 (12.5 inches)	240.0	8+	8	large; Madagascar
310.0	230.0	10	9	large; Cebu, Phil. Ids.
285.0	200.0	7+	8	female, Oahu, Hawaii
253.0	180.0	7+	7+	male; Oahu, Hawaii
225.0	192.0	9+	8	male?; Red Sea
54.5	40.9	8	6	immature; Cebu Id.
17.5	11.8	7	2	immature; Hawaii

#### Synonymy—

- 1758 *Buccinum cornutum* Linné, *Systema naturae*, ed. 10, p. 735 (in *America* [erroneous]); refers to Buonnani, pl. 155; Rumphius, pl. 23, fig. 1; Gualtieri, pl. 40, fig. D; 1764, *Mus. Lud. Ulricae*, p. 602, no. 249; 1767, ed. 12, p. 1198, no. 445; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 111, p. 175.
- 1792 *Cassidea cornuta* Bruguière, *Encyclopéd. Méthod.*, Vers, vol. 1, p. 434, no. 17. Non *Cassidea cornuta* Perry, 1811, a *Melongena corona* Gmelin, 1791 (*Conchology*, pl. 34, no. 3).
- 1798 *Cassis caput-equinum* Röding, *Museum Boltenianum*, Hamburg, pt. 2, p. 28, no. 340; refers to *Conchyl. Cab.*, vol. 2, fig. 362; Lister, pl. 1008.
- 1798 *Cassis hamata* Röding, loc. cit., p. 219; refers to Lister, pl. 1009, fig. 71c.
- 1817 *Cassis labiata* "Chemnitz" Dillwyn, *Descr. Cat. Recent Shells*, vol. 2, p. 589 (in synonymy).
- 1822 *Cassis madagascariensis* Lamarck, *Anim. sans Vert.*, vol. 7, p. 219 [in part, by referring to Rumphius, pl. 23, fig. 1, which is a young *cornuta* Linné].

1885 *Cassis amboinensis* "Petiver" and *brevirostrum* "Petiver", Tryon, *Manual of Conch.*, Philadelphia, vol. 7, p. 271 (in synonymy of *cornuta* Linné).

1916 *Cassis cornuta* Linné, Staub, *Vierteljahrsschrift Naturforschenden Gesellschaft in Zurich*, vol. 61, p. 125, 132 (east Borneo); 1925, Oostingh, *Mededeel. Landbouwhoog. Wagen. Nederl.*, vol. 29, p. 113 (synonymies); 1935, Bayer, *Zoologische Mededeel.*, vol. 18, p. 93-94; 1927, Iredale, *Records Australian Mus.*, vol. 15, p. 327.

1961 *Cassis cornuta* Linné, Weaver, *Hawaiian Shell News*, vol. 9, no. 12, p. 1, fig. of egg mass; vol. 10, no. 2, p. 1, fig. of male and female shell.

**Types**—Apparently Linné's type specimen is not in existence. A specimen is in the Linnaean collection at Uppsala, Sweden, according to Dodge (1956, p. 177), but was probably not in Linné's possession in 1758 when the species was first described. The type locality "In America" is incorrect. The best of Linné's figure references is to "*Cassis cornuta* Rumphius", pl. 23, fig. 1, which is a young or female specimen.

**Records**—TANGANYIKA: Inner Sinda Id., Dar-es-Salaam (R. T. Abbott, ANSP); Inner Makatumbe Id., Dar-es-Salaam (J. F. Spry, coll'n). ZANZIBAR: 8 fms., 1- $\frac{1}{2}$  mi. W.S.W. of Ras Nungwi (A. J. Ostheimer, 3rd, ANSP). RED SEA: (Sozon Vatikiotis, ANSP; lower half of Red Sea only, fide A. Hadar *in litt.*). MADAGASCAR: Andilana, Nossi-bé (Ruth Ostheimer); Tulear (R. W. Foster, MCZ and ANSP). INDIAN OCEAN IDS.: Mauritius (Mauritius Inst.); Seychelles (ANSP); Salomon Id., Chagos Archip. (Eda Couacaud, *in litt.*, 1962); Maldive Ids.: Hulule Id. (E. A. Smith, 1903, p. 611). INDIA: off Bombay (Chari, 1960, *Jour. Bombay Nat. Hist. Soc.*, vol. 53, p. 736); 8-10 fms., Gulf of Manaar, S.E. India (Hornell, 1951, p. 22). MALAYA: east coast, 40 mi. east of Mersing (D. J. Parkinson coll'n). SINGAPORE: Tio-man Id. (Andrew Peters, *in litt.*). JAPAN: Amami-Oshima (Kuroda, 1928, p. 50, Cat. Shell-bearing Moll. Amami-Oshima). RYUKYU IDS.: Mubutu Peninsular, Okinawa Id. (Bernice Albert, ANSP). FORMOSA: Takao (Kuroda, 1941, p. 104). PARACEL IDS.: (E. Saurin, 1961, p. 209). PHILIPPINES: Badang, Sorsogon Prov., Luzon; Cuyo Id.; Borongan, Samar; Olango Id., Cebu Id. (all duPont-Academy Exped., 1958); Siasi, Sulu Archip.; Siquijor Id. (both USNM). BORNEO: 5 fms., Malawali Id., British North Borneo (Mary Saul, ANSP). INDONESIA: Medan, Sumatra; Madura, Java; Billiton Id., Java; Amboina, Ambon Id., Banda Id.; Timor



Id.; Aru Id.; Nias Id.; Obi Id.; Waigeu Id. (all Rijksmus. Nat. Hist. Leiden); Baie de Paloe, Donggala, Celebes; Poeltoetjoch, north Ceram Id. (Priester, Roy. Inst. Nat. Hist. Bruxelles); Geser Atoll, Ceram Id. (N. E. Weisbord, Paleo. Res. Inst.); Tjilang, Atjeh, Sumatra; Sangir Id., north of Celebes; Pekalongan, Java Id. (all Zool. Mus. Amsterdam). NEW GUINEA: Roun Isle, Aeori Ids., Geelvinck Bay (A. J. Ostheimer, 3rd, ANSP); Sorong, Ile Dom (Roy. Inst. Nat. Hist. Bruxelles); Waisor, Wandamen Bay; Fak Fak (both Zool. Mus. Amsterdam). BISMARCKS: Rabaul, New Britain Id. (Schlosser, 1962, ANSP). AUSTRALIA: 15 fms., 125 mi. north of Darwin, Northern Territory (Vernon Wells, ANSP); Wreck Reef and Michaelmas Cay, Queensland (both Aust. Mus.); Green and Low Id., off Cairns, Queensland (Tony Marsh, *in litt.*). SOLOMONS: Choiseul Id. (W. J. Eyerdam, USNM). PALAU IDS.: west barrier reef, Ngauangel; Babelthuap Id.; north end, Kayangel Id. (all A. J. Ostheimer, 3rd., ANSP). CAROLINES: Ulithi Atoll (USNM); Ifalus (USNM); Truk Id. Peter R. Hill, (ANSP). MARSHALLS: Eniwetok Atoll (E. J. Kuenzler, 1960, ANSP); Arno (John Wells); Eniaetok Id., Rongelap Atoll (USNM). NEW CALEDONIA: Hedley, 1899, p. 455). ELLICE IDS.: Funafuti; Nukulaelae (both Hedley, 1899, p. 455). SAMOA: reef at Satalo Id., Upolu Id. (A. J. Ostheimer, 3rd, ANSP); Pago Pago, Tutuila Id. (BPBM). PHOENIX IDS.: Howland Id. (ANSP). SOCIETY IDS.: 5 ft., black sand, Arahiri, Arue Tahiti (R. Robertson, ANSP). TUA-MOTU IDS. (Mus. Nat. Hist., Paris). HAWAIIAN ISLANDS: Niihau Id.; Lanai Id. (both BPBM); Maui Id. (USNM); 40 ft., sand, Rabbit Id., Oahu Id. (C. S. Weaver, ANSP); 4-12 fms., off Launiupoko, Maui Id. (young; D. Thaanum, USNM).

*Fossil records*—UPPER MIOCENE: Tjilang beds of Java, Indonesia (K. Martin, 1879, p. 45, pl. 8, fig. 5, 5a).

### *Cassis preangerensis* K. Martin, 1899

(Pl. 21)

*Range*—Middle Miocene, Preangerian; Java, Indonesia.

*Remarks*—This *Cassis* is not unlike the Recent *cornuta*, but it has a more rugose surface caused

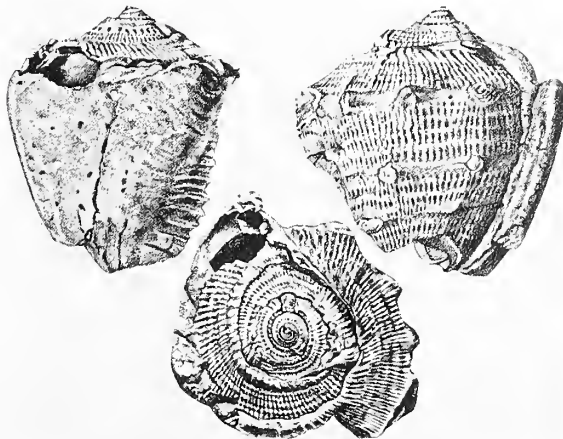


Plate 21. *Cassis preangerensis* K. Martin, 1899. Upper Miocene or Pliocene of Java Island, Indonesia. 62 mm. in (broken) length. (from K. Martin, 1899, pl. 24, figs. 354).

by numerous small axial pittings. The top of the whorls in the spire are also more strongly sculptured than those of *cornuta*. Cossmann (1909, p. 125) thought the age might be Pliocene. R. van Bemmelen (1949, vol. 1A, p. 81) considers the age to be Middle Miocene.

### *Synonymy*—

1899 *Cassis preangerensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. I, pt. I, p. 153, pl. 24, figs. 354, 354a, 354b (Preanger-Regentschaften, Java; Upper Miocene).

### *Cassis depressior* K. Martin, 1879

(Pl. 22, figs. 1, 2)

*Range*—Upper Miocene, Tjilang beds of Java, Indonesia.

*Remarks*—The type is a very poorly preserved *Cassis* about 65 mm. in length which is characterized by numerous, crowded, long, small, axial riblets. The shell surface lacks the pittings found on specimens of *C. cornuta* (Linné).

### *Synonymy*—

1879 *Cassis depressior* K. Martin, Die Tertiärschichten auf Java, Leiden, p. 44, pl. 8, figs. 4, 4a (Liotjilangkang, near Genung Sela, Tjilang beds of Java; Upper Miocene); 1883, Samml. Geol. Reichsmus. Leiden, ser. I, vol. I, p. 219 (Tji Longan at Selatjan, Tjilang beds).

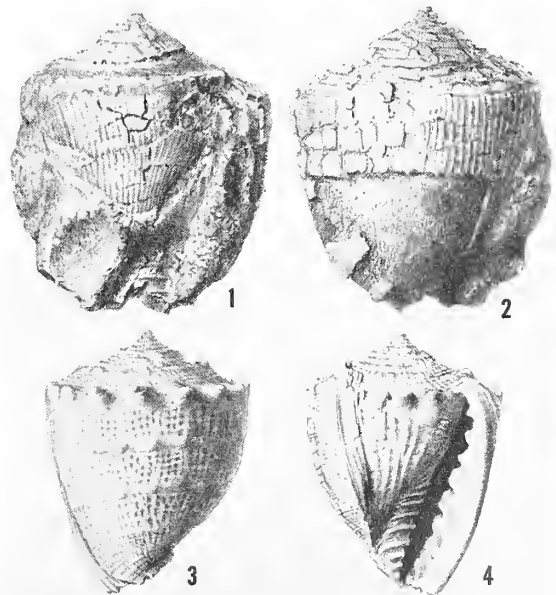


Plate 22. Figs. 1, 2, *Cassis depressior* K. Martin, 1879. Upper Miocene, Tjilang beds, Java Island, Indonesia. (from K. Martin, 1879, pl. 8, fig. 4). Figs. 3, 4, *Cassis cornuta* (Linné) from the same locality. (from K. Martin, 1879, pl. 8, figs. 5, 5a).



***Cassis tuberosa* (Linné, 1758)**

(Pl. 3, fig. 11; pl. 23)

*Range*—Caribbean province from off North Carolina, Bermuda, and Florida south to Brazil. Miocene of Trinidad.

*Remarks*—This common West Indian species reaches a length of 4 to 9 inches, and is characterized by its heavy, somewhat triangular parietal shield, by its coarse, reticulated surface and 7 to 8 broad, dark-brown color spots extending over the width of the varices. Very old specimens may have a very pointed parietal shield similar to that found in the fossil species *sulcifera* Sowerby. The species was treated in full by Clench, 1944, pp. 11-12. To the synonymy I add *triangularis* Coulon, 1936, but remove the non-binomial reference of *Buccinum striatum* Meuschen, 1787, which is a turrid. Meuschen's "*Cassides*" occur on pp. 386-395, but none is accepted.

The spines of the sea urchin, *Lytechinus* [*Toxopneustes*] *variegatus* (Lamarck), were found in the digestive tract of this species (Frank

Lyman, 1937, *Nautilus*, vol. 51, p. 34), and the heart urchin, *Clypeaster rosaceus* (Linné), is eaten in the Bahamas by this species (Richard W. Foster, *Nautilus*, vol. 61, p. 35). Off Conch Reef, Lower Florida Keys, this *Cassis* feeds on the white sea urchin, *Tripneustes esculentus* (Leske), according to Donald R. Moore (*Nautilus*, vol. 69, pp. 73-76).

**Synonymy—**

- 1758 *Buccinum tuberosum* Linné, *Syst. Nat.*, ed. 10, p. 735 (locality unknown); 1767, edition 12, p. 1198, no. 447.
- 1791 *Buccinum striatum* Gmelin, *Systema naturae*, ed. 13, p. 3477, no. 33 (in America); refers to Gronovius, pl. 19, fig. 18.
- 1792 *Cassidea tuberosa* Bruguière, *Encyclop. Méthod.*, vol. 1, pt. 2, p. 436 (Guadeloupe, etc.).
- 1866 *Cassis tuberosa* var. *triquetra* Rigacci, *Catalog. Conch. Collezione Rigacci*, Rome, p. 44, no. 4324 (Bahamas). Nude name.
- 1936 *Cassis triangularis* Coulon, *Bull. Soc. d'Etude Sciences Naturelles d'Elbeuf*, vol. 55, p. 67 [substitute name for *C. tuberosa* Lamarck].
- 1944 *Cassis tuberosa* Linné, Clench, *Johnsonia*, vol. 1, no. 16, p. 11.

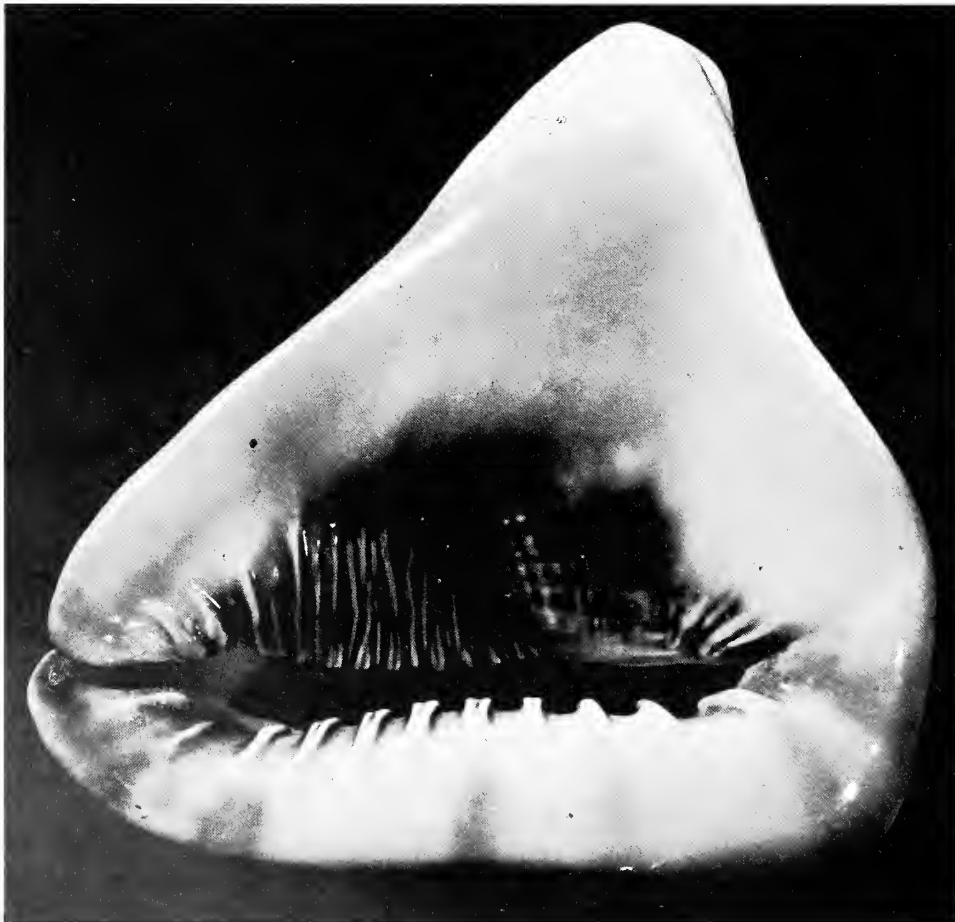


Plate 23. A gerontic specimen of *Cassis tuberosa* (Linné) showing the extreme development of the parietal shield caused by excessive deposits of shell material in old age.

Length: 19 cms. (7 1/2 inches). Collected by Daniel Malone, 1968, on Delta Shoals, Marathon, Florida.

**Cassis delta Parker, 1948**

(Pl. 24, figs. 1, 2)

**Range**—Miocene of southeastern United States (Chipola formation, Ten Mile Creek, Clarksville, Florida).

**Remarks**—This medium-sized, very solid *Cassis* is evidently related to *C. tuberosa* (Linné) of the Recent West Indian fauna and to *C. sulcifera* Sowerby, 1850, of the Lower and Middle Miocene of the Caribbean area. It may be a synonym of the latter. It is known only from an adult 134 mm. in length and from three immature specimens.

**Synonymy**—

1948 *Cassis delta* Parker, Nautilus, vol. 61, no. 3, p. 91, pl. 6, figs. 1, 1a, 1b, 2, 2a, 2b (Bank of Ten Mile Creek on the east side of the bridge of Florida highway no. 84, 4.7 miles north of Clarksville, Calhoun Co., Florida, Chipola formation).

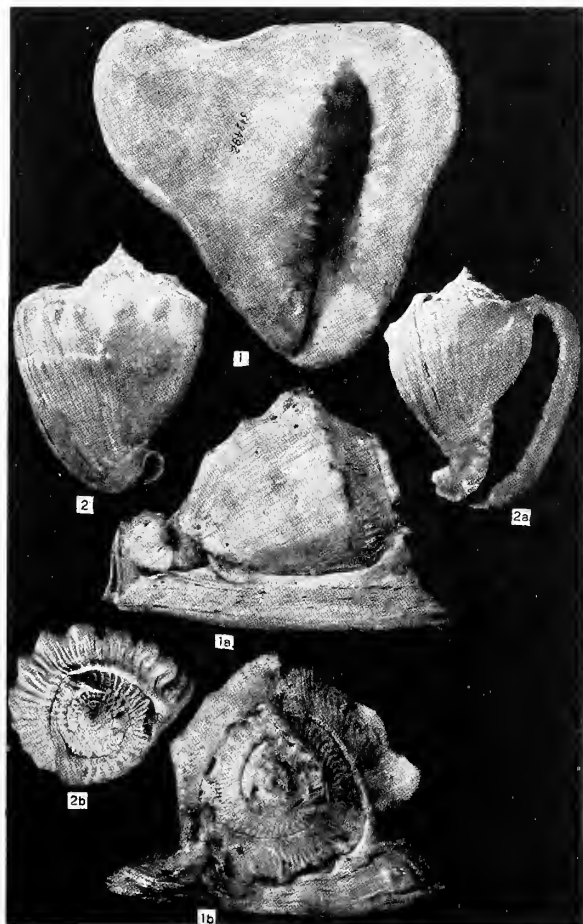


Plate 24. *Cassis delta* Parker, 1948. Miocene, Chipola formation. Ten Mile Creek, Florida. (from Parker, Nautilus, vol. 61, pl. 6). Fig. 1 is 134 mm. in length.

**Cassis subtuberosa Hanna, 1926**

(Pl. 25)

**Range**—Lower Pliocene of Imperial County, southern California.

**Remarks**—This species bears a close resemblance to the Caribbean living *C. tuberosa* (Linné). Schenck (1926, p. 75) said it differs "in having less spinose tubercles, absence of distinct posterior denticles on inner lip, and callus on inner lip more expanded anteriorly." The holotype is 113 mm. (about 5 inches) in length, and about the size of some living and possibly immature *tuberosa* which are as equally weakly spinose. The type (no. 31275) and paratype (no. 31276) are in the Univ. Calif. Coll. Invert. Paleo. according to Schenck.

**Synonymy**—

1926 *Cassis subtuberosa* Hanna, Proc. Calif. Acad. Sci., 4th series, vol. 14, p. 444, pl. 20, fig. 8; pl. 29, figs. 2, 3 (Alverson Canyon, Coyote Mountain, Imperial Co., Calif.; Lower Pliocene); 1926, Schenck, Bull. Dept. Geol. Sci., Univ. Calif., vol. 16, p. 75, pl. 12, figs. 2 and 3.



Plate 25. *Cassis (Cassis) subtuberosa* Hanna, 1926. Holotype from Imperial County, California. Length: 113 mm. (from Schenck, 1926, pl. 12, figs. 2, 3).

**Cassis flammea (Linne, 1758)**

(Pl. 3, figs. 7 and 8)

**Range**—Caribbean province from Bermuda and Florida to the Lesser Antilles.

**Remarks**—This 3 to 5 inch-long *Cassis* is moderately common in shallow water, and is characterized by its lack of reticulated sculpturing, by its ovate shield, by the lack of brown between the teeth on the outer lip, and by its relatively small size. Clench, 1944, p. 12, treated this spe-

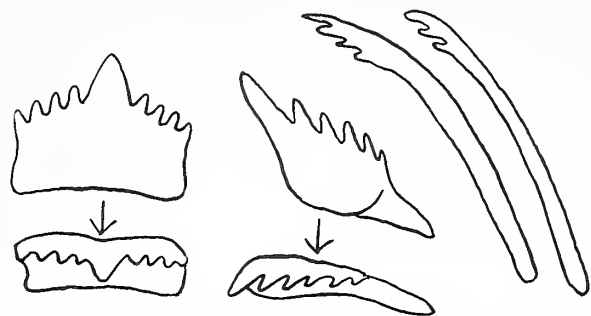


Plate 26. *Cassis flammea* (Linné). Radulae of female from Grenada, Lesser Antilles.

cies in detail. To his synonymy should be added *Cassis marmorata* Röding (1798, p. 29, no. 351; refers to Conchyl.-Cab., vol. 2, figs. 381, 382 and Knorr, pt. 3, pl. 10, figs. 1 and 2). *Cassis alba* Perry, 1811 is also a synonym, as is *Cassis elegans* Grateloup, 1838 (non 1827), Tableau Statist. Coq. Univalves Fossiles, Bordeaux, p. 9, no. 41. Russell Jensen (*in litt.*, 1965) reports this species live from Bermuda. Robert Klein has found it live in 10 to 16 feet of water off Islamorada, Lower Florida Keys.

### *Cassis madagascariensis* Lamarck, 1822

(Pl. 3, fig. 9)

**Range**—Off North Carolina and Bermuda to the West Indies.

**Remarks**—This large, moderately common *Cassis* reaches a length of 14 inches and is characterized by its cream-colored exterior and

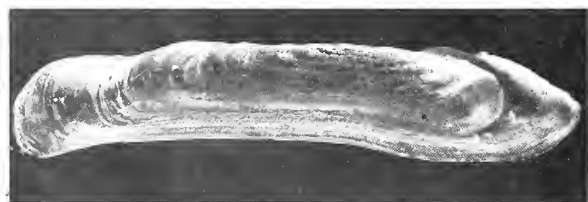


Plate 27. Operculum of *Cassis madagascariensis* Lamarck. Isla Mujeres, Yucatan, Mexico. Shell, 100 mm.; operculum, 32.5 mm.

a parietal shield which is black and salmon-tinted. The species appears to have two forms which in some areas may be associated with sex differences. The more rotund form with more numerous, smaller nodules, known from North Carolina, the Lower Florida Keys and more recently reported (Warmke and Abbott, 1961, Caribbean Seashells, p. 99) from Puerto Rico was originally described as the subspecies *spinella* Clench, 1944 (*Johnsonia*, vol. 1, no. 16, p. 15, off Tortugas, Florida). *Cassis cameo* Stimpson, 1860, a nude name, is *madagascariensis* Lamarck, 1822. *Cassis rotundata* Perry, 1811 (*Conchology*, pl. 33, no. 1) is also a synonym. The name has not been used for over 100 years, and I reject it, and apply to the I.C.Z.N. for its declaration as a nomen oblitum. *Cassis madagascariensis* var. *major* and *minor* Rigacci, 1866 (*Cat. Conch. Collezione Rigacci*, Rome, p. 44, no. 4314) from the Bahamas, are nude names.

Donald R. Moore (1956, *Nautilus*, vol. 69, pp. 73-76) reports that this species digs in the sand to feed on the giant heart urchin, *Plagiobrissus grandis* (Gmelin) in the Lower Florida Keys. The *Cassis* drills a hole through the thin test or shell of the urchin. Schroeder (1962, *Sea Frontiers*, vol. 8, pp. 156-160) says *Diadema antillarum* (Philippi) is also one of its foods.

**Records**—(additional since *Johnsonia*, 1944) MEXICO: live and common on Isla Mujeres, Yucatan (Wesley Heilman, 1963, ANSP). NORTH CAROLINA: off Cape Lookout (Hugh Porter, 1964). VENEZUELA: Punta Cardon; Punta Arenas-Esta; Playa Guaigua; Punta Boton; Ensenada Matacual (C. Flores, 1966, p. 13, figs. 2-5). BERMUDA: live, Castle Roads, St. Georges (J. R. H. Lightbourn, 1966).

**Fossil records**—PLIOCENE: VENEZUELA: Mare Formation, in stream 250 meters S.S.W. of the mouth of Quebrada Las Pailas (N. E. Weisbord, 1962, *Bulls. Amer. Paleont.*, Ithaca, vol. 47, p. 251, pl. 23, fig. 9, 10).

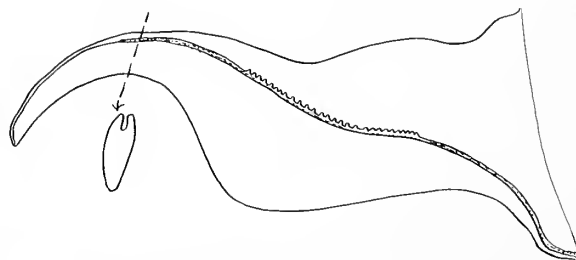


Plate 28. *Cassis madagascariensis* Lamarck. Penis, 100 mm. in length, from male from off Lower Florida Keys, showing the open seminal groove which is bordered by a short row of fleshy serrations.



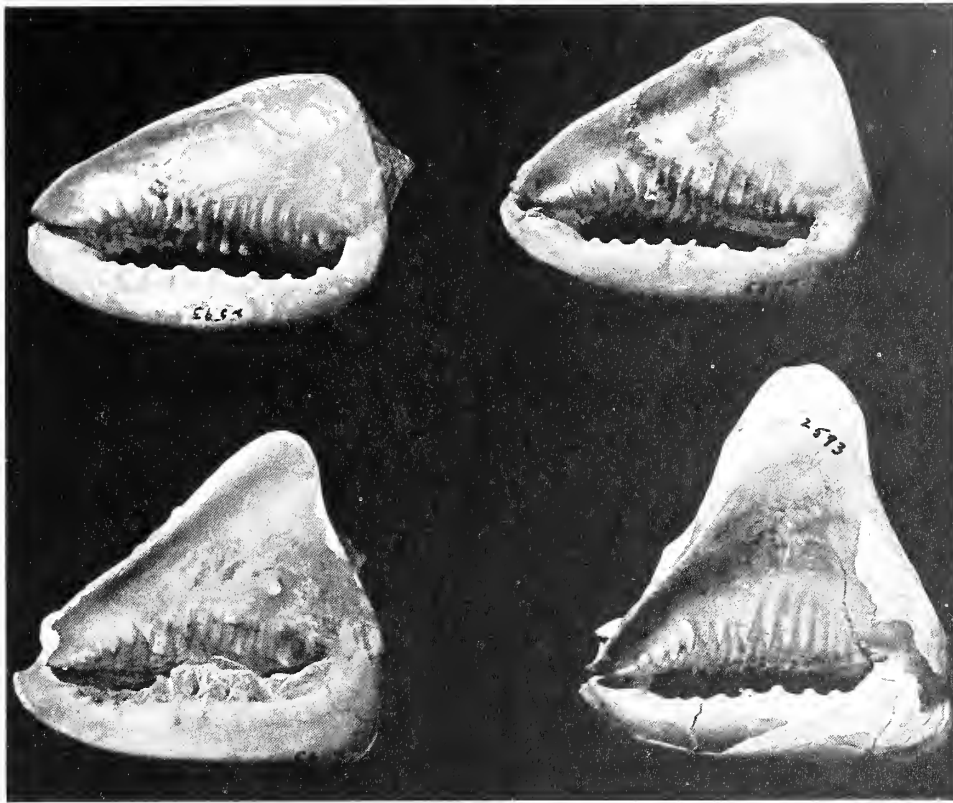


Plate 29. *Cassis sulcifera* Sowerby, 1850, showing variations in the development of the parietal shield. The lower

right figure is the oldest specimen. Miocene of Santo Domingo. Length of top left shell: 62 mm.; others in same scale.

### *Cassis sulcifera* Sowerby, 1850

(Pl. 29)

*Range*—Lower and Middle Miocene of Panama, Santo Domingo, Jamaica, Trinidad, and Oligocene and Miocene of southeast United States.

*Remarks*—Woodring (1928, see below) gives a full synonymy up to 1928 of this common Tertiary species of the Caribbean.

#### *Synonymy*—

- 1850 *Cassis sulcifer* Sowerby, Quart. Jour. Geol. Soc., London, vol. 6, p. 47, pl. 10, fig. 1 (Santo Domingo; Miocene); 1928, Woodring, Publ. no. 385, Carnegie Inst. Washington, Pt. 2, p. 304-306, 1948, Rutsch, in Stainforth, Amer. Assoc. Petroleum Geologists Bull., vol. 32, pt. 7, p. 1318 (Trinidad; Lower Miocene).  
 1916 *Cassis sulcifera* Sowerby, Dall Proc. U.S. National Museum, vol. 51, no. 2162, p. 508, pl. 86, fig. 4 (Oligocene, near Bainbridge, Flint River, Decatur County, Georgia, at several localities).  
 1940 *Cassis flintensis* Mansfield, Journal of Paleontology, Wisconsin, vol. 14, no. 3, p. 214, pl. 27, figs. 47-49 (Flint River, Georgia).

### *Cassis tessellata* (Gmelin, 1791)

(Pl. 3, figs. 5, 6)

*Range*—West Africa from Senegal south to Loanda, Angola.

*Remarks*—This is a West African (Dunker, 1853) and not an Australian species as stated by Gmelin (1791), Hedley (1923) and Iredale (1927). Its nomenclature has been confusing, and it has also been called *spinosa* Gronovius and *rumpfii* Gmelin.

*Cassis tessellata* (Gmelin) reaches a length of about 10 inches (267 mm.), and it is characterized by its comparatively lightweight shell, by the 2 or 3 spiral rows of very small knobs on the upper fifth of the body whorl, by the two axial rows of "teeth" or denticles on the whitish outer lip, and by its strongly beaded spire. It has no close living relative, either in the Caribbean or Indo-Pacific. Superficially, it resembles the South Australian *Cassis fimbriata*, but that species has much larger nuclear whorls, lacks the strong beading in the spire, and has numerous, short, spiral, brown lines on the body whorl.



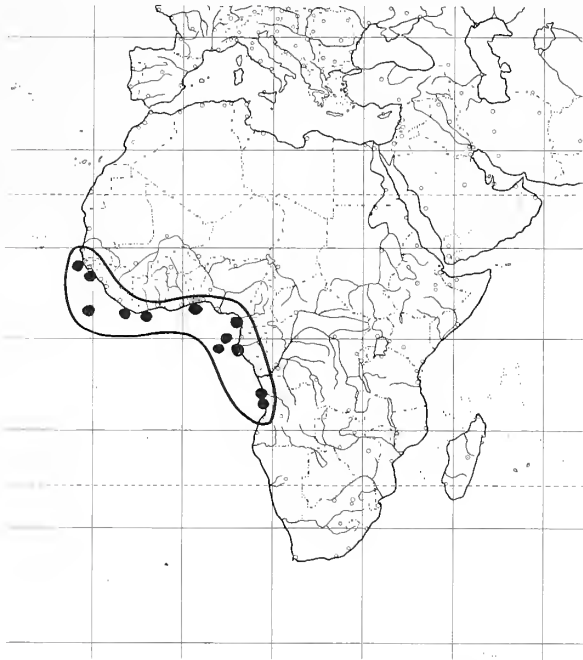


Plate 30. Geographical distribution of *Cassis (Cassis) tessellata* (Gmelin).

**Habitat**—This *Cassis* lives offshore on sand bottoms in depths down to about 27 fathoms. Specimens are occasionally washed ashore (Buchanan, 1954, Jour. West African Sci. Assoc., vol. 1, no. 1, p. 36).

**Description**—Shell 90 to 267 mm. (3½ to 10 inches) in length, somewhat elongate, thin-shelled, with 2 or 3 spiral rows of very small knobs on the upper part of the whorl, and colored a tan-cream with spiral rows of small, crescent-shaped, light-brown spots. Nuclear whorls 3, small, smooth, opaque-tan. Post-nuclear whorls with 3 or 4 spiral threads which are coarsely beaded. Whorls 9 to 10. Shoulder with 2 or 3 spiral rows of fine knobs. Suture irregular and bounded below by numerous, crowded, axially elongated beads. Spire with 8 or 9 former varical lips. Parietal shield poorly developed, allowing the spotted coloration of the whorl to show through. Columella white, with 6 to 8 strong plications in the middle, and with 3 or 4 small, glossy, sharp, round nodules near the base. Outer lip broad, white, rarely with tan spotting, and bearing an inner edge of 8 to 10 strong teeth beside which may be a corresponding second row of sharp nodules. Interior of aperture flushed with dark tan. Body whorl cream or tan and with 8 narrow, spiral bands of alternating patches of white and yellow-brown. Umbilicus sealed or minutely open; false umbilicus narrowly open. Anterior siphonal canal short and leaning to the

left. A short, poorly-developed posterior canal may be produced in some adult specimens. Operculum and soft parts unknown.

**Measurements (mm.)—**

length	width	no. whorls	no. varices	
267.0	160.0	9+	9	large; Accra, Ghana (AMNH)
218.0	131.0	10+	10	Accra, Ghana (ANSP).
113.6	76.0	10+	8	Gaboon, West Africa
72.3	46.5	9	7	small; "West Africa"

**Synonymy—**

- [1781 *Buccinum spinosum* Gronovius, Zoophylacium, vol. 3, p. 302, pl. 19, fig. 9. Not binomial]; 1927, Iredale, Records Australian Mus., vol. 15, p. 327.
- 1791 *Buccinum tessellatum* Gmelin, Systema naturae, ed. 13, p. 3476, no. 20 (in Oceano australi); refers to Seba, pl. 73, figs. 1, 12, 13; Conchyl.-Cab., vol. 2, figs. 369, 374. Non Martyn, 1789 which, however, is non-binomial; 1817, Dillwyn, Descriptive Cat. Recent Shells, London, vol. 2, p. 596.
- 1791 *Buccinum maculosum* Gmelin, loc. cit., p. 3476, no. 22 (no locality); refers to Lister, pl. 997, fig. 62. Non Martyn, 1789, a species which was validated in I.C.Z.N. opinion 479.
- 1791 *Buccinum rumpfii* Gmelin, loc. cit., p. 3491, no. 90 (no locality); refers solely to Rumphius, pl. 25, fig. 3; 1923, Hedley, Records Australian Mus., Sydney, vol. 14, no. 1, p. 47.
- 1792 *Cassidea fasciata* Bruguière, Encyclop. Méthod., Vers, vol. 1, pt. 2, p. 430 (mer du Sud); refers to Lister, pl. 997, fig. 62; Seba, pl. 73, figs. 1, 12, 13; Conchyl.-Cab., vol. 2, figs. 369, 374; and to others. Not *Buccinum fasciatum* Brug., which is a *Tonna*.
- 1798 *Cassis coronata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 29, no. 358; refers to Conchyl.-Cab., vol. 2, figs. 369, 374.
- 1844 *Cassis spinosa* Gronovius, Deshayes, Hist. Nat. Anim. sans Vert., ed. 2, vol. 10, p. 23, footnote; 1848, Reeve, Conch. Icon., vol. 5, *Cassis*, pl. 4, sp. 9 (Australia [error]); 1935, Bayer, Zoologische Mededeel. Rijksmus. Nat. Hist., Leiden, vol. 18, p. 95; 1950, Nicklés, Mollusques Test. Marins Côte Occid. d'Afrique, Paris, p. 85, fig. 129.
- 1927 *Cassis spinosa* (Meuschen), Iredale, Records Australian Mus., vol. 15, p. 327 (Australia).

**Types**—Gmelin may not have had a specimen of either his *tessellatum*, *maculosum* or *rumpfii*. A type locality was given only for *tessellatum*, but "in Oceano australi" is evidently erroneous. We designate Accra, Ghana, as an appropriate new type locality.

**Records**—(all West Africa from about 12° North to 10° South latitudes) Cosamance (Nicklés, 1950, p. 85); south of Ile de Orange, N. Lat. 10° 22'; W. Long. 16° 22'. Atlantide Sta. 44, 41-55 meters; off Conakry, N. Lat. 9° 23'; W. Long. 15° 07', Atlantide Sta. 45, 30-34 meters (both Zool. Mus. Copenhagen); Lomé, Togo (David Ogg, ANSP); Robertsport, Liberia (Rijksmus. Nat. Hist. Leiden); Cape Palmas (USNM), Ivory Coast (Nicklés, 1950, p. 85); 50 meters, off Ouidah, Dahomey. A. Crosnier, July 23, 1964; Accra, Ghana (ANSP; AMNH); Sherbro Id. (A. Hurd, Yale Peabody Mus.); Little Eloby Id. (Zool. Mus. Berlin); Sao Thomé Id. (G. R. Batalha, 1878, p. 18); Bay of Cape Lopez (USNM); Duala, Cameroons (Roy. Inst. Nat. Hist. Brussels); Gaboon (ANSP); Loanda, Angola (Dunker, 1853, p. 23).

**Fossil records**—None recorded.

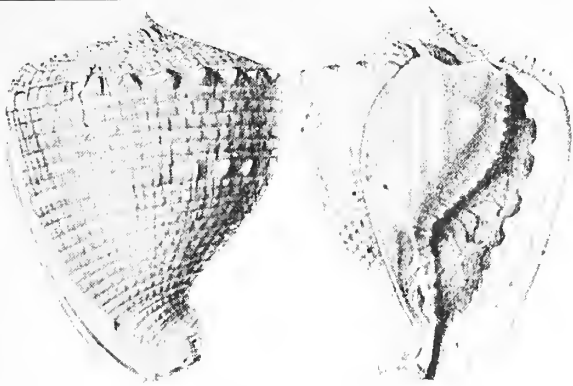


Plate 31. *Cassis jogiacartensis* K. Martin, 1914. Upper Eocene of Java Island, Indonesia. Holotype. 90 mm. in length. (from K. Martin, 1914, pl. 5, fig. 118).

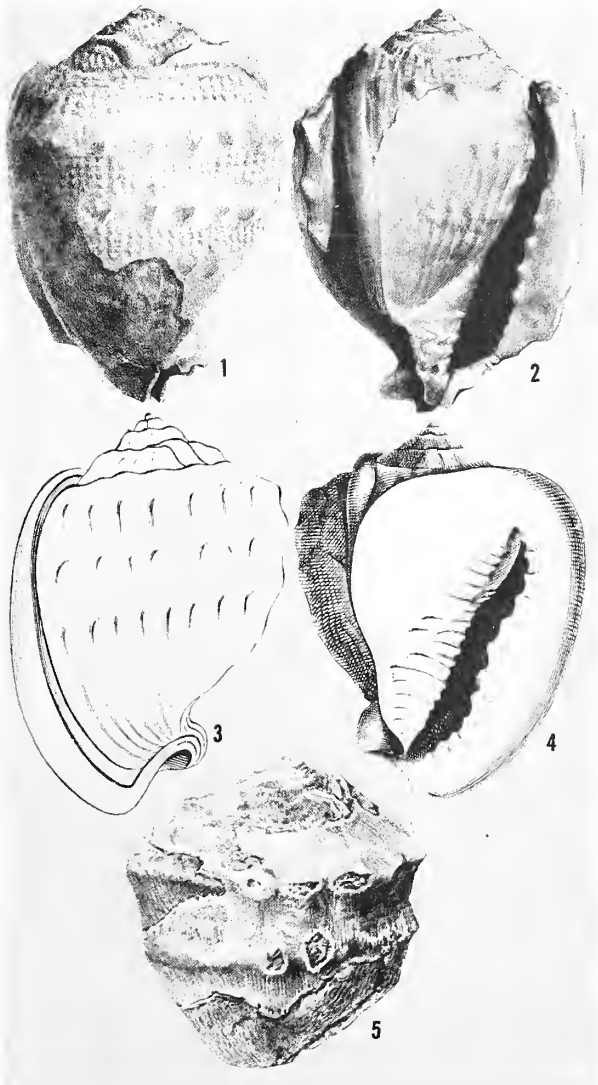


Plate 32. *Cassis mamillaris* Grateloup, 1827. Figs. 1, 2, subspecies *bellardii* Michelotti, 1847. Tertiary of Italy. 123 mm. (from Bellardi and Michelotti, 1841, pls. 4 and 5). Figs. 3, 4, subspecies *major* Grateloup, 1834, Tertiary of France (from Grateloup, 1840, Atlas, vol. 1, suppl., pl. 2, figs. 2a, b.). Fig. 5, subspecies *retusa* Michelotti, 1861. Holotype. Lower Miocene, Italy. 20 mm.

*Cassis jogiacartensis* K. Martin, 1914  
(Pl. 31)

*Range*—Upper Eocene (?), Nanggoelan beds of Java.

*Remarks*—This small, 38 mm.-long *Cassis* appears to be distinct from any other members of the genus in having rather strong, round, spiral cords and only one instead of two rows of low knobs on the middle of the last whorl. The small, evenly-sized, rounded knobs on the shoulder are similar to those found in young Recent *Cassis*. The type has 8 whorls and it might be a young specimen.

The Nanggoelan beds in my opinion may be Oligocene, although van Bemmelen (1949, Geol. of Indonesia, vol. 1A, p. 80) does not entirely abandon the view that the age may be Upper Eocene as originally proposed by Martin.

*Synonymy*—

1914 *Cassis jogiacartensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 2, p. 154, pl. 5, fig. 118 (Kali Puri, Nanggoelan beds, Java).

*Cassis mamillaris* Grateloup, 1827

*Range*—Burdigalian Miocene of France, and Oligocene of Italy and Armenia.

*Remarks*—The typical *mamillaris* from the Dax in France is a heavy, rather massive cassid with a thick, oval shield, and with crude spiral rows of axially aligned, blunt nodules. A number of forms or closely related species are known from the Tertiary of Europe, but without more material at hand it would be difficult to ascertain the relationships.

The form or subspecies *Cassis mamillaris major* Grateloup, 1834, from Gaas, France (South Aquitainian, Oligocene) is claimed to be distinct from typical *mamillaris* by Cossmann and Peyrot, 1923, p. 72. The form or subspecies *pedemontana* Sacco, 1890, from the Miocene of Torino, Italy, is extremely close to *major*, and may well be a synonym.

*Synonymy*—

1827 *Cassis mamillaris* Grateloup, Bull. d'Hist. Nat. Soc. Linnéenne Bordeaux, vol. 2, pt. 7, p. 19 (St-Paulles-Dax, Landes, France); 1833, Tableau Coq. Fossile. . . Dax, vol. 6, p. 198; 1840, Conchyliologie Fossile. . . l'Adour Bordeaux, Atlas, vol. 1, pl. 34, figs. 4 and 19; 1963, Glibert, Inst. Royal Sci. Nat. Belgique, Mémoires, ser. 2, fasc. 73, p. 113; 1870, Fuchs, Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.-Natur., Wien, vol. 30, p. 175, pl. 1, figs. 3, 4; 1961, Aslanyan, Doklady Akad-

emii Nauk SSSR, vol. 136, no. 4, p. 931, fig. 1k (Keara-Molla, Yerevan, S.W. Armenia).

- 1903 *Cassidea mamillaris* Grateloup, Cossmann, Essais de Paléoconchologie Comparée, Paris, vol. 5, p. 124, pl. 5, fig. 10; 1923, Cossmann and Peyrot, Actes Société Linnéenne Bordeaux, vol. 75, p. 71, pl. 12, figs. 12-13 (Aquitaine).

***Cassis mamillaris***  
***subspecies bellardii* Michelotti, 1847**  
 (Pl. 32, figs. 1, 2)

*Range*—Miocene of Turin, Italy.

*Remarks*—This distinctive form is characterized by its oval shape, and by a peculiar mucronate sculpture between the three rows of evenly-sized nodules.

*Synonymy*—

- 1841 *Cassis flammea* Brug., Bellardi and Michelotti, Memorie Reale Accademia Scienze di Torino, ser. 2, vol. 3, p. 144, pl. 4, fig. 4, pl. 5, fig. 1.  
 1847 *Cassis bellardii* Michelotti, Naturkundige Verhandl. Hollandsche Maatschappij Wetenschappen te Haarlem, ser. 2, vol. 3, p. 216. Refers to Bellardi and Michelotti, pl. 4, and pl. 5 (La Colline de Turin).  
 1852 *Cassis subflammea* Orbigny, Prodrome Paléontologie Stratigraph. Universelle, Paris, vol. 3, p. 90, no. 1677. Refers to Bellardi and Michelotti, pl. 4, fig. 4, pl. 5, fig. 1.  
 1904 *Cassidea mamillaris* var. *bellardii* Micht., Sacco, I Molluschi Terr. Terziar Piemonte e della Liguria, pt. 30, p. 96, pl. 20, fig. 1 (Colli Torinesi).

***Cassis mamillaris***  
***subspecies postmamillaris* Sacco, 1890**

*Range*—Miocene of Italy.

*Remarks*—This subspecies of *mamillaris* is characterized by a rather massive, triangular parietal shield, resembling the Recent *Cassis tuberosa* of the Caribbean.

*Synonymy*—

- 1890 *Cassis postmamillaris* Sacco (and var. *volutilithoides* Sacco) I Moll. Terreni Terziarii Piemonte Liguria, pt. 7, p. 16, pl. 1, fig. 11 (Tortoniano: Stazzano, Italy).

***Cassis mamillaris***  
***subspecies apenninica* Sacco, 1890**

*Range*—Oligocene of Italy.

*Remarks*—Although this may be an extreme morphological variation of *mamillaris*, I am treating it as a subspecies. In its general shape and well-developed spines it resembles some of the Recent *Cassis* such as young *cornuta* and *tuberosa*.

*Synonymy*—

- 1890 *Cassis mamillaris* var. *apenninica* Sacco, I Moll. Terreni Terziarii Piemonte Liguria, pt. 7, p. 11, pl. 1, fig. 3 (Tongriano: S. Giustina, Carcare, Oligocene).  
 1923 *Cassis apenninica* [sic] Sacco, Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 72.

***Cassis mamillaris***  
***subspecies nummulitiphila* Sacco, 1890**

*Range*—Oligocene of Italy (and India?).

*Remarks*—This subspecies or form is characterized by its oval shape and by the strong axial plicae on the last whorl. Vredenburg (1925) reported this subspecies from the Miocene, Nari Beds of India, but I suspect that it is probably not identical. He gave the Indian shells the subvariety name *indica*.

*Synonymy*—

- 1890 *Cassis mamillaris* var. *nummulitiphila* Sacco, I Moll. Terreni Terziarii Piemonte Liguria, pt. 7, p. 11, pl. 1, fig. 4, 5a, 5b (Tongriano: Dego, Nornese, Carcare, Pareto, etc.).  
 ?1925 *Cassidea mamillaris* Grat. var. *nummulitiphila* Sacco, Vredenburg, Memoirs Geol. Survey of India, vol. 50, pt. 1, p. 259 (subvariety *indica*, p. 262).

***Cassis mamillaris***  
***subspecies major* Grateloup, 1827**  
 (Pl. 32, figs. 3, 4)

*Range*—Oligocene and Miocene of France and Italy.

*Remarks*—The more elongate shape and the three rows of small, somewhat evenly-sized nodules on the body whorl separate this form or subspecies from the typical *mamillaris*. Sacco in 1890 illustrated and named a number of morphological varieties.

*Synonymy*—

- 1834 *Cassis mamillaris* var. *major* Grateloup, Actes Soc. Linn. Bordeaux, vol. 6, pt. 35, p. 198; 1840, Conchyl. Fossiles. . . l'Adour, vol. 1, pl. 47, fig. 2 (Gaas, France, South Aquitainian, Oligocene).  
 1890 *Cassis mamillaris* var. *pedemontana* Sacco, I Moll. Terreni Terziarii Piemonte Liguria, pt. 7, p. 13, pl. 1, figs. 6a, 6b (Elveziano: Albugnano and Colline di Torino, Italy, Miocene). Also subvarieties *quinqueseriata* Sacco (p. 13), *taurinensis* Sacco (p. 13, fig. 8).  
 ?1925 *Cassidea mamillaris* Grat. var. *pedemontana* Sacco, Vredenburg, Memoirs Geol. Survey of India, vol. 50, pt. 1, p. 263 (Gaj of Kachh, India, Miocene).

***Cassis mamillaris***  
***subspecies retusa* Michelotti, 1861**  
 (Pl. 32, fig. 5)

*Range*—Lower Miocene and Oligocene of Italy.

*Remarks*—This species was based upon a poorly preserved specimen which closely resembles *mamillaris*. Until more specimens are known, its true relationship to *mamillaris* will remain undetermined. Sacco (1890) reported



it from the Oligocene of Italy. (*Cassidaria retusa* Deshayes, 1875, does not preoccupy this name).

#### Synonymy—

- 1861 *Cassis retusa* Michelloti, Natuurkundige Verhandel. Holland. Maatsch. Wetenschappen te Haarlem, ser. 2, vol. 15, p. 133, pl. 13, figs. 9, 10 (Mioglia, Italy); 1890, Sacco, I Moll. Terreni Terziarii Piemonte Liguria, pt. 7, p. 15 (Dego, Lower Miocene, Italy).

#### *Cassis jauberti* (Cossmann and Peyrot, 1924)

*Range*—Lower Miocene of Aquitaine, France.

*Remarks*—Although this 96 mm. cassid was originally described as a *Semicassis*, I am assigning it to the genus *Cassis*, for it closely resembles such forms as *Cassis mamillaris* Grateloup of about the same age. It is possible that the peculiar, rather sharp teeth on the parietal wall are a sign that the specimens are not fully mature. In details of sculpture, it resembles *C. mamillaris* subspecies *major* Grateloup, 1834.

#### Synonymy—

- 1924 *Semicassis jauberti* Cossmann and Peyrot, Actes Société Liméenne Bordeaux, vol. 75 (for 1923), p. 83, no. 716, pl. 17, figs. 29-31 (Léognan, Burdigalien, France).

#### *Cassis saccoi* Rovereto, 1900

*Range*—Oligocene of Italy.

*Remarks*—This species is an elongate form showing characters of both *Cypraecassis* and *Cassis*. Sacco proposed the subgenus *Galeodocassis* for this kind of cassid. *Cassis anceps* Sacco, 1890 (non H. and A. Adams, 1858) was re-named *saccoi* Rovereto, 1900. The subgenus has been rejected by most workers, and has been put in the synonymy of *Cassis*.

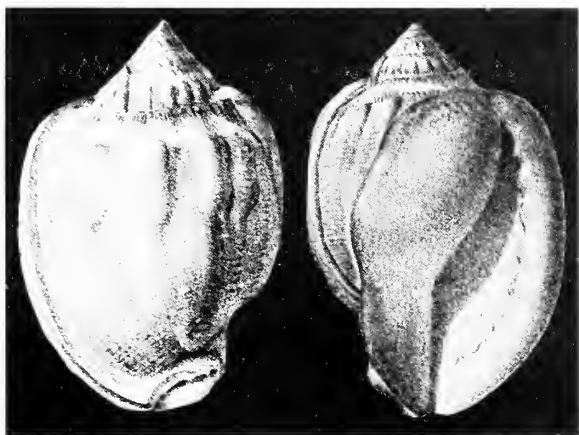


Plate 33. *Cassis thesei* Brongniart, 1823. Eocene of Italy. Holotype. 37.8 mm.

#### Synonymy—

- 1890 *Cassis* (*Galeodocassis*) *anceps* Sacco, I Molluschi Terreni Terziarii Piemonte, pt. 7, p. 18, pl. 1, fig. 12 (with subvar. *crassinodosa* Sacco, 1890). Non *Cassis anceps* H. and A. Adams, 1858.  
1890 *Cassis* (*Galeodocassis*) *subharpaeformis* Sacco, loc. cit., p. 19, pl. 1, fig. 13, Non d'Archiac and Haime, 1854.  
1900 *Cassisoma saccoi* Rovereto, Illustrazione dei Molluschi Fossili Tongriani, p. 162, pl. 9, fig. 2. New name for *anceps* Sacco.  
1904 *Cassis* (*Galeodocassis*) *sacci* [sic] Rovereto, Sacco, I Molluschi Terr. Terz. Piemonte, pt. 30, p. 96, pl. 20, fig. 2.

#### *Cassis thesei* Brongniart, 1823

(Pl. 33)

*Range*—Eocene of Italy.

*Remarks*—I have not seen the type of this Italian Eocene species. It is provisionally placed in *Cassis*, although it has some parietal features usually associated with *Phalium*. I believe *Cassis aeneae* Brongniart, described from the same area, is merely a young specimen of *thesei*. *Cassis gregorii* Schlosser, 1925, may be a synonym.

#### Synonymy—

- 1823 *Cassis thesei* Brongniart, Mémoire sur les Terrains de Sédiment Supérieurs Calcaréo-Trappéens du Vicentin, Paris, p. 66, pl. 3, fig. 7a, b (Ronca, Italy).  
1823 *Cassis aeneae* Brongniart, loc. cit., p. 66, pl. 3, fig. 8a, b (Ronca, Italy).  
1841 *Cassis thaesei* Brong., Bellardi and Michelotti, Memorie Reale Accademia Scienze Torino, ser. 2, vol. 3, p. 144.  
1841 *Cassis oeneoe* Brongniart, Bellardi and Michelotti, loc. cit., p. 145.

#### *Cassis vialensis* Fuchs, 1870

*Range*—Tertiary of Vicentin, Italy.

*Remarks*—This is a broken specimen which is either a true *Cassis* or possibly a *Cypraecassis*.

#### Synonymy—

- 1870 *Cassis vialensis* Fuchs, Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.-Natur. Classe, Wien, vol. 30, p. 172, pl. 1, figs. 1, 2 (Monte Viale, Italy; Tertiary).



*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*

### Subgenus *Coalingodea* Durham, 1942

Type: *Cassis* (*Coalingodea*) *tuberculata* Gabb, 1864

This Californian Eocene species appears to be midway between certain European Miocene *Cassis* and living members of the genus *Phalium* s.s. It was previously placed in *Galeodea* by several American workers, and seemed sufficiently novel for Durham (1942, p. 186) to have created a new genus, despite the fact that no specimens having a perfect siphonal canal were known. The "naticoid" nuclear whorls, "honeycomb" sculpture, the existence of several former varices, and the well-developed parietal shield, all suggest the genus *Cassis*, and not *Galeodea*. The sculpturing of the first few postnuclear whorls are also *Cassis*-like, and unlike the numerous, fine spiral threads of *Galeodea*.

The contour and spiral sculpturing or wrinkles on the columella and the thickened outer lip are like those in some *Phalium*. The lack of a "gutter" or groove posterior to the siphonal canal separates this subgenus from all *Phalium* and most, but not all *Cassis*.

For nomenclatural reasons mentioned below, Gabb's name *tuberculata* is not pre-occupied, so that Hanna's replacement name, *tuberculiformis*, need not be used.

#### Synonymy—

1942 *Coalingodea* Durham, Jour. of Paleontology, vol. 16, no. 2, p. 186 (type by original designation: *Galeodea tuberculiformis* Hanna, 1926 = *Morio* (*Sconsia*) *tuberculatus* Gabb, 1864).

### *Cassis tuberculata* (Gabb, 1864)

(Pl. 34)

**Range**—Eocene; Domengine in California and Clallum County, Washington.

**Remarks**—This unique species has been discussed by Vokes (1939, p. 149) and Durham (1942, p. 186) in some detail. In my opinion it is not a *Galeodea*. Vokes made the following descriptive remarks:

"This species may be distinguished from all other West Coast species of *Galeodea* in the possession of a well-developed series of denticles on the outer lip, which is reflected and thickened. Varices on the earlier whorls of the shell are almost universally present, and were observed on all the specimens examined, although Schenck (1926, p. 83) notes that they may be absent.

"The protoconch is naticoid, consisting of 4 smooth whorls, slightly tabulate at the impressed suture. The first succeeding whorl is characterized by 3 well-developed spiral riblets, the sutural riblet being smooth, the anterior two nodose. Approximately one third of the circumference from the end of the protoconch longitudinal ribs appear in the interspaces. On the succeeding whorls fine intercalated spiral threads

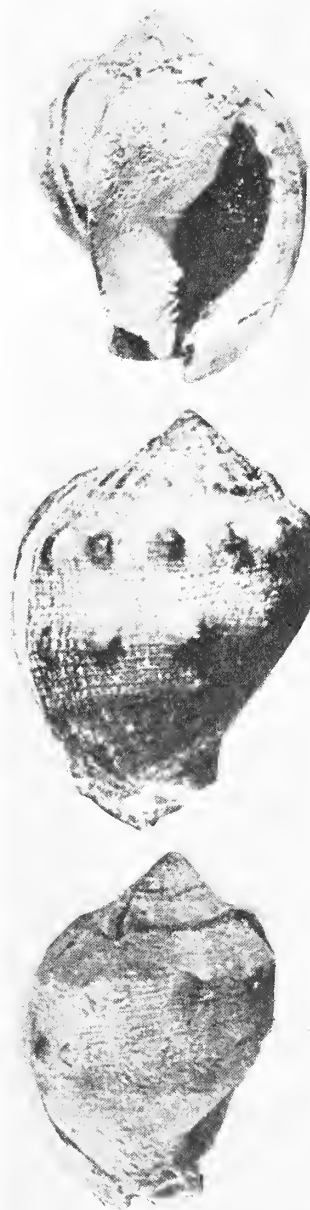


Plate 34. *Cassis* (*Coalingodea*) *tuberculata* (Gabb, 1864). Crest of Parson's Peak, Domengine formation, Coalinga, California, Eocene. Length: 20.2 mm. for largest figure. (from Vokes, 1939, pl. 19, figs. 23, 25 and 27).

appear, the nodose character of the most anterior thread becomes accentuated while the middle thread tends to appear beaded, loses its primary distinctness, and is not separable from the other threads on the shoulder of the body-whorl.

"The number of nodose carinae on the body-whorl varies. On the smallest specimen examined the shoulder of the whorl alone is carinated. This is the anterior riblet of the post-nuclear whorl. The other specimens show 2 or 3 carinae. When the anterior carina is not noded its position is marked by a spiral thread, which is slightly stronger in its development than the normal threads on that portion of the whorl."

Durham was in error in saying that the protoconch of *Galeodea* is low and naticoid. It is high, bulbous, and with rapidly descending whorls.

There have been six names of *tuberculata* proposed in Cassidae, but curiously none preoccupy Gabb's 1864 name. *Cassidaria tuberculata* Risso, 1826 (a synonym of *Phalium* (*Echinophoria*) *intermedium* Brocchi, 1814) is neither a primary nor secondary homonym. *Cassidea tuberculata* G. Fischer, 1807 is doubtfully *Phalium fimbria* Gmelin, although it perhaps should be considered a *nomen dubium*. *Cassis tuberculata* Meuschen, 1787, is non-binomial. Weinkauff's 1867 and Sacco's 1890 *tuberculata* are *Phalium*, and unless Gabb's species is placed in *Phalium* or in *Coalingodea* as a full genus by future workers, Hanna's replacement name of *tuberculiformis* need not be used.

I am provisionally placing *crescentensis* Weaver and Palmer, 1922, in the synonymy of this species.

*Description* (from Schenck, 1926, p. 83)—"Shell small to medium, with a somewhat depressed spire, appressed sutures, body whorl with three tuberculous keels, outer lip strongly reflexed and lirate (in well-preserved specimens), inner lip forming a broad, rather thick callus free anteriorly. Sculpture: A smooth nuclear whorl followed by nepionic whorl characterized by axial riblets; in the next whorl,

vertical riblets more nodulous, and penultimate whorl distinguished by one row of distinct nodes axially elongate and with revolving threads becoming pronounced. Body whorl carrying three rows of nodes: uppermost row at shoulder of whorl and bears 8-12 nodes, depending upon thickness of callus; anterior to this keel is another well-developed row of nodes; between these two rows shell has beaded appearance, owing to intersecting of growth striae and spiral threads; immediately anterior to the two well-developed rows is a third, somewhat less developed but quite distinct, row with the low nodes axially offset from row above, with beaded appearance persisting, though not so markedly as between first two rows. Spire low, about one-third height of body whorl. Whorls about 5, at first sharply descending, but on the last whorl descent less abrupt, forming a shoulder that makes nearly a right angle with axis of coiling. Aperture ovate, rather narrow, with shallow posterior canal and drawn out anteriorly into comparatively long, recurved anterior canal. Inner lip callused, free anteriorly. Outer lip reflected and heavy, more lirate anteriorly than posteriorly."

#### *Synonymy—*

- 1864 *Morio* (*Sconsia*) *tuberculatus* Gabb, Geol. Surv. Calif. Paleo., vol. 1, p. 104, pl. 19, fig. 57 (Eocene, Martinez, California); 1894, Turner and Stanton, Amer. Geologist, vol. 14, p. 95 (New Idria); 1927, Stewart, Proc. Acad. Nat. Sci. Phila., for 1926, p. 380, pl. 28, fig. 11 (lectotype no. 4343, and complete synonymy).
- 1916 *Galeodea tuberculata* (Gabb), Dickerson, Univ. Calif. Publ. Geol., vol. 9, p. 433, pl. 42, fig. 2 (Domengine Creek).
- 1922 *Galeodea tuberculata* (Gabb) var. *crescentensis* Weaver and Palmer, Univ. Wash. Pub. Geol., vol. 1, no. 3, p. 36, pl. 11, figs. 18, 20 (Port Crescent, Clallam Co., Wash.; Eocene).
- 1924 *Galeodea tuberculiformis* Hanna, Proc. Calif. Acad. Sci., series 4, vol. 13, no. 10, p. 167. New name for *tuberculata* Gabb, not *Cassidaria tuberculata* Risso, 1826; 1926, Schenck, Univ. Calif. Publ. Bull. Geol. Sci., vol. 16, no. 4, p. 83, pl. 14, figs. 12-16; Vokes, 1939, Annals New York Acad., vol. 38, p. 149, pl. 19.
- 1942 *Coalingodea tuberculiformis* (Hanna), Durham, Jour. of Paleontology, vol. 16, no. 2, p. 186, pl. 29, fig. 9.

### Subgenus *Hypocassis* Iredale, 1927

Type: *Cassis fimbriata* Quoy and Gaimard, 1833

This subgenus differs little from true *Cassis*. The gutter posterior to the upturned siphonal canal is very shallow. The nuclear whorls of the shell of the type species are large and bulbous, but another Australian species, *nana*, has nuclear whorls intermediate in size. The lower columellar region in *fimbriata* is weakly toothed, but in *nana* it is strongly lirate, as in true *Cassis*. There are two living species, both limited to Australia. Iredale's generic description of *Hypocassis* does not differ from that of any other *Cassis*. *Nannocassis* Iredale, which I consider a synonym of *Hypocassis*, seems to be intermediate between *Cassis* and *Hypocassis*. It could be also synonymized with *Cassis*.

### Synonymy—

1927 *Hypocassis* Iredale, Records Australian Museum, Sydney, vol. 15, p. 322, 329. (type by original designation: *Cassis bicarinata* var. *decrensensis* Hedley = *C. fimbriata* Quoy and Gaimard, 1833).

1927 *Nannocassis* Iredale, Records Australian Museum, Sydney, vol. 15, p. 322, 328. (type by original designation: *Cassis nana* Tenison-Woods, 1879).

### *Cassis fimbriata* Quoy and Gaimard, 1833

(Pl. 4, figs. 1-4; pl. 37)

**Range**—Within the Flindersian province of southern Australia from the Abrolhos Islands, Western Australia, to Portland, western Victoria.

**Remarks**—This handsome, medium-sized *Cassis* is moderately common throughout its limited range. It is characterized by its somewhat globose shape, the two rows of small nodules on the shoulder, the 5 to 7 former varices showing in the spire, and the fine, broken, spiral lines of chestnut-brown on the body whorl.

This shell is variable in several characters throughout its entire range, and, in my opinion, cannot be divided into geographical races nor be considered as two species in the process of hybridizing. The extreme forms led Hedley (1923, p. 46) to accept *C. fimbriata* Quoy and Gaimard and *C. bicarinata* Jonas as different

species. Iredale (1927, p. 329) kept them separate with reservations, but Cotton attempted to reinforce the differences by outlining four variants within *bicarinata*. Among the hundred specimens examined from 50 localities, I find gradual intergrades between these variants, but do not know if sexual dimorphism is responsible or not. The two most striking variants are:

- a) shell 2 to 3-1/2 inches in length; darkly colored with dark-brown maculations and axial zigzag bands; with two spiral rows of 12 to 15 rather large, sharp nodules; columella and inside of outer lip with very reduced teeth. (Pl. 4, figs. 3 and 4).
- b) shell 3 to 4 inches in length; somewhat elongate; reddish-brown to light brown in coloring; shoulder smooth except for faint crowded axial wrinkles; columella and inside of outer lip with strong teeth. (Pl. 37).

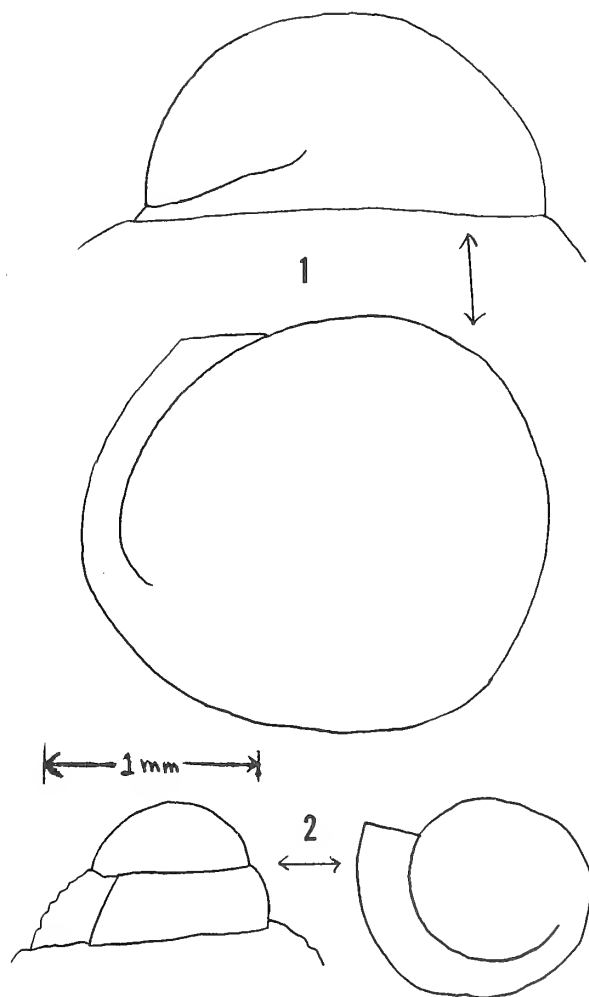


Plate 35. Nuclear whorls of *Cassis* (*Hypocassis*). Fig. 1, *fimbriata* Quoy and Gaimard. Fig. 2, *nana* Tenison-Woods.



The commonest form is illustrated in our Pl. 4, figs. 1 and 2. Curiously, the nuclear whorls may be moderately to greatly swollen in any of the variants, regardless of geographical origin. Hedley's form *decreasensis* appears to be between the commonest form and our form b mentioned above. The intensity of coloration varies somewhat from locality to locality, but is mainly due to the state of preservation and age of the shell. The height of spire varies widely with no geographical correlation. Some Western Australia specimens may have a beautiful pinkish mauve hue.

*Habitat*—From intertidal, sandy beaches to depths of 100 fathoms. Cotton (1945, p. 168) reports "45 living specimens being counted by me at high tide mark on Sellicks Beach in 1935." It has been dredged in moderately large numbers between 9 and 15 fathoms in Spencer and St. Vincent Gulfs.

*Description*—Adult shell about 76 to 128 mm. (3 to 5 inches) in length, globose, solid, shining, greenish to yellowish gray with axial maculations of chestnut-brown and with 8 to 12 broken spiral lines of dark brown. Whorls 6 to 7. Nuclear whorl usually swollen, bulbous, smooth, and yellow or white. Spire with an angle of 80 to 110 degrees and bearing 5 to 7 brown-blotched former varices, each one about 230 degrees of a complete turn from the other.

Suture irregularly and well-indented. Whorls in spire with numerous axial, wavy wrinkles which are commonly clumped in pairs. Last whorl with irregular, axial growth lines, giving

a peculiar shingling appearance. Spiral sculpture of 3 rows of 13 to 20 evenly-sized tubercles, the upper two rows at the shoulder being the strongest, the lowest row sometimes obsolete. Some variants lack tubercles and have a rounded, axially wrinkled shoulder. Umbilicus narrow but deep and bounded by the penultimate varix. Parietal shield moderately developed, usually reflected above so as to meet the suture above. Center of parietal shield thin with the coloring showing through. Base of shield whitish and with 4 or 5 short, oblique lirae. Columella cream to tan with 3 to 7 weak or rarely strong lirae. Inside of outer lip smooth or rarely (especially in young) with 14 or 15 weak denticles. Last varix reflected especially at the upper to middle third, glossy tan and with 5 to 7 broad bars of chestnut-brown. Base of outer shell with numerous, fine spiral threads. Interior of the recurved siphonal canal is brownish.

Operculum thin, chitinous, light-yellow, oblong, semi-concentric, and about  $\frac{1}{4}$  the length of the aperture. According to Cotton (1945, p. 167), "the animal has a large foot which is white, round behind, uniformly but less curved in front; on its upper surface is a brown line about two millimeters broad, complete posteriorly where it is produced to the edge. The tentacles are short, pointed, white at the distal ends and at the proximal half. The eyes are placed halfway down on the outer side, and just beyond these for one-half of the part distal to them the colour is pink. The undersurface of the foot is quite white."

*Measurements (mm.)*—(spire height from last suture behind varix to apex)

length	width	spire height	spire angle (degrees)	no. whorls	no. varices	nodules on last whorl	
117	78	22	80	6	8	15	Cape Arid, Western Australia
105	78	14	110	6	8	16	off Cedune, South Australia
98	69	14	110	7	8	20	Portland, Victoria
94	65	17	100	6	8	20	Portland, Victoria
92	64	18	100	6	8	17	Glenelg, South Australia
90	55	22	80	7	8	too small	Glenelg, South Australia
87	55	19	100	6	7	too small	Glenelg, South Australia
77	55	15	90	6	7	13	Albany, Western Australia
68	46	12	100	6	7	too small	Albany, Western Australia
60	42	10	95	6	5	13	Glenelg, South Australia

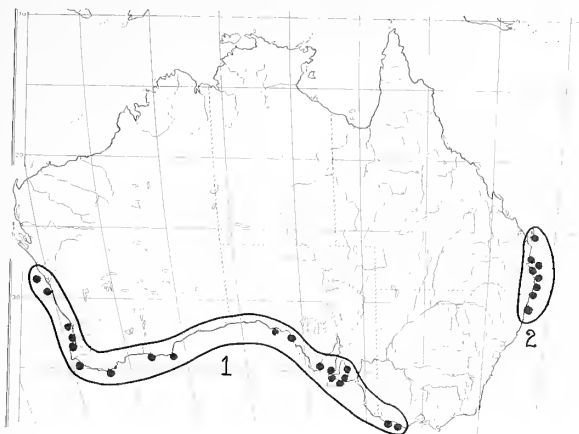


Plate 36. Geographical distribution of *Cassis* (*Hypocassis*). 1, *fimbriata* Quoy and Gaimard. 2, *nana* (Tenison-Woods).

### Synonymy—

- 1826 *Cassis flammea* Lam., Gray, in King's Narrative Survey Coasts of Australia, vol. 2, appendix, p. 485, no. 60. Not Lamarck, nor Linné.
- 1833 *Cassis fimbriata* Quoy and Gaimard, in d'Urville's Voyage Astrolabe, Zoologie, vol. 2, p. 596, pl. 43, figs. 7, 8 (? îles Mariannes ou Carolines); 1835, Kiener, Coquilles Vivantes, vol. 8, Cassis, p. 12, pl. 4, fig. 6; 1848, Reeve, Conch. Iconica, vol. 5, pl. 7, fig. 17; 1923, Hedley, Records Australian Mus., vol. 14, no. 1, p. 47, pl. 8, fig. 2; 1927, Iredale, Records Australian Mus., vol. 15, p. 329.
- 1839 *Cassis bicarinata* Jonas, Archiv für Naturgeschichte, Berlin, 5th year, vol. 1, p. 343, pl. 10, fig. 2 (mare chinense); 1923, Hedley, Records Australian Mus., vol. 14, no. 1, p. 47, pl. 8, fig. 1; 1927, Iredale, *ibid.*, vol. 15, p. 330.
- 1923 *Cassis bicarinata* var. *decreseensis* Hedley, Records Australian Museum, vol. 14, no. 1, p. 47 (Kangaroo Island) refers to Kiener, 1835, pl. 4, fig. 6.
- 1927 *Hypocassis bicarinata* var. *decreseensis* Hedley, Records Australian Museum, vol. 15, p. 329, 330.
- 1927 *Hypocassis bicarinata* (Jonas), Iredale, Records Australian Mus., vol. 15, p. 320; 1945, Cotton, Trans. Royal Soc. South Australia, vol. 69, p. 167, text figs.; 1954, Cotton, Records South Australian Mus., vol. 11, no. 2 (animal and operculum fig'd.).
- 1927 *Hypocassis fimbriata* (Quoy and Gaimard), Iredale, *loc. cit.*, p. 319; 1945, Cotton, *supra cit.*, p. 168.

*Types*—I was unable to locate the type of *Cassis fimbriata*. The type locality of “?Îles Mariannes ou Carolines” is erroneous. Jonas' type of *bicarinata* is not in the Berlin Museum. Hedley (1923, p. 46) “restricted” the type locality of *fimbriata* to Albany, Western Australia. Cotton (1945, p. 167) restricted the type locality of *bicarinata* to the Gulf of St. Vincent, South Australia. The type locality of Hedley's variety *decreseensis* is Lacépède Bay, Kangaroo Island, South Australia. His type is in the Australian Museum in Sydney, no. C.30803.

*Records*—WESTERN AUSTRALIA: Abrolhos Islands (Miss Green, West. Aust. Mus.); Beagle Id. (Poole brothers, West. Aust. Mus.); Cottesloe beach, Perth; 9 fms. off Dunsborough, Geographe Bay (B. R. Wilson, West. Aust. Mus.); Bunbury (Cotton, 1945, p. 168); Duke of Orleans Bay (R. W. George, West. Aust. Mus.); 10 miles east of Cape Leeuwin (USNM); Albany and King George Sound (Nat. Mus. Vict.); Eucla (V. Wells, ANSP); Esperance; Eyres Sand Patch (both



Plate 37. *Cassis* (*Hypocassis*) *fimbriata* Quoy and Gaimard, 1833. Holotype of *C. bicarinata decreseensis* Hedley. Off Kangaroo Island, South Australia. Australian Museum no. C. 30803.

Cotton, 1945, p. 168); Cape Arid (West. Aust. Mus.); SOUTH AUSTRALIA: off St. Francis Id., off Ceduna (T. Hartley, ANSP); Bolingbroke Pt., Boston Bay (Mrs. J. A. Grigg, ANSP); Investigator Straits, 15 fms.; Rapid Bay, 9 fms. (all Cotton, 1945, p. 167); Normanville, Gulf of St. Vincent (T. Hartley and J. A. Grigg, ANSP); Pine Pt., Yorke Peninsula (Nat. Mus. Vict.); Aldinga Bay, Gulf of St. Vincent (MCZ); Yankallilla Bay (Nat. Mus. Vict.); Semaphore and Glenelg, Adelaide (Nat. Mus. Vict. and ANSP). VICTORIA: Portland (Nat. Mus. Vict.); Port Fairy (Cotton, 1945, p. 168).

*Fossil records*—None known to me.

### ***Cassis exigua* Tenison-Woods, 1879**

(Pl. 38)

*Range*—Oligocene or Miocene, Muddy Creek, Victoria, Australia.

*Remarks*—This species is extremely close to the Recent South Australian *C. fimbriata* Quoy and Gaimard, differing only in having a fourth, lower, spiral row of nodules on the body whorl. The type specimen is young, and in 1889 Tate further illustrated and described adult specimens:

"Shell stout, oblong-ovate, ventricose, with a very short conic spire, ending in a small pullus [nucleus] of one and a half smooth swollen turns, with the tip reverted and immersed. Whorls five, excluding pullus, variced at successive intervals of about two-thirds of a whorl, the first whorl transversely corrugate and spirally striate; sutures granulosely marginate.

"Last whorl with a very high back, somewhat precipitous over the suture; bearing on the angle a row of 12 compressed sharp-pointed tubercles, and on the medial portion two other rows equidistantly placed, but of smaller size, a fourth inconspicuous row is developed on the adult shell. Base somewhat cancellated.

"Aperture narrow, sinuously curved at each end; outer lip flattened, inflected, and slightly reflected, plicately dentate. Inner lip widely spreading, projecting behind as a thin plate, and terminated by the varix, over which it projects. Columella strongly dentately wrinkled throughout, as well as the anterior portion of the callous-covering. Length, 40; breadth of last whorl, 30; height, 27; length of aperture, 37; but attains to a length of 52."

#### *Synonymy*—

1879 *Cassis exigua* Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. 4, p. 17, pl. 2, fig 7 ("Lower beds of Muddy River"); 1889, Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 164, pl. 7, fig. 13; 1896, Harris, Cat. Tertiary Mollusca, pt. 1, p. 197; 1935, Davies, Tertiary Faunas, London, vol. 1, p. 271, fig. 387 (Balcombian, Muddy Creek, Victoria).

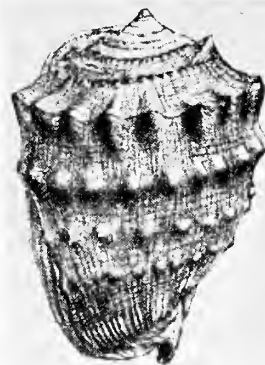


Plate 38. *Cassis (Hypocassis) exigua* Tenison-Woods, 1879. Lower Beds of Muddy Creek, Victoria, Australia. Tertiary. Length: 40 mm. (from Tate, 1889, pl. 7, fig. 13).

### ***Cassis salisburyensis* Ludbrook, 1958**

*Range*—Pliocene of Adelaide, South Australia.

*Remarks*—(from Ludbrook's original) "A small, [42 × 30 mm.] stout *Hypocassis* moderately ventricose with a short spire. Body whorl with 10 prominent tubercles, on the posterior angle of the whorl, decreasing in number and prominence in a second and third row of tubercles at the middle of the whorl. Outer lip denticulate. This species is intermediate between *C. textilis* Tate and *C. exigua* Tenison-Woods. It differs from *exigua* in being less strongly sculptured on the spire and in having 3 rows of less numerous tubercles. It differs from *textilis* in having 10 instead of nine tubercles on the body whorl and in being less inflated, with a lower spire. It is a much smaller and thicker shell than *C. fimbriata* Quoy. I believe it might be a subspecies of the Recent *fimbriata* Quoy and Gaimard, and possibly a synonym of *exigua*.

#### *Synonymy*—

1958 *Cassis (Hypocassis) salisburyensis* Ludbrook, Transactions Royal Society South Australia, vol. 81, p. 51, pl. 2, figs. 1, 2. (Tennant's Bore, Salisbury; Pliocene of the Adelaide Plains, South Australia).



**Cassis nana Tenison-Woods, 1879**

(pl. 4, figs. 5, 6; pl. 39)

*Range*—Eastern Australia.

*Remarks*— This very attractive species is the smallest living *Cassis*. Adults are only 1 to 2-1/4 inches in length, and are characterized by two spiral rows of rounded knobs on the shoulder, by the spot-less, flattened varix, by the sealed umbilicus and by the absence of axial wrinkles on the top of the whorls in the spire. The latter feature readily distinguishes *nana* from the young of *Cassis cornuta* Linné and *C. fimbriata* Quoy and Gaimard. In some specimens of *nana*, a third, fourth and rarely fifth spiral row of very subdued nodules may be present.

*Habitat*—Locally it is moderately common on sand bottoms at depths of 30 to 120 fathoms. It is uncommon in collections.

*Description*—Adult shell 30 to 58 mm. (1-1/4 to 2-1/4 inches) in length, solid, rotund, with 2 spiral rows of about 8 to 11 even-sized, small

knobs on the shoulder of the dorsum; with a thin, sharp-edged parietal shield and with a well- but finely-toothed inner and outer lip; and taffy-brown in color. Nuclear whorls only 1-1/2, small but bulbous, smooth and ivory-yellow. Post-nuclear whorls 6, with weak spiral striae which disappear after the third or fourth whorl. Suture finely impressed, wavy, and bounded on both sides by weak, tiny knobs. Last whorl with 3, rarely 4, spiral, low cords, the upper two bearing 8 to 11 small knobs on the shoulder of the dorsum. Varices 5 to 6. Parietal shield broad, but thin, and with a thin, sharp edge. Columella with numerous, fine, short, white, spiral plicae. A channellike, smooth depression in the middle gives a gnarled appearance to the inner lip. Glossy, whitish, broad outer lip is bounded on its inner edge by about 14 small denticles. Aperture narrow; white within. Body whorl tan with 4 or 5 narrow, spiral bands of alternating blotches of darker tan and white. Surface with microscopic, axial scratches which give a "silky" or "watery" effect. Siphonal canal short, recurved toward the left. Umbilicus usually sealed by an extension of the posterior side of the parietal shield. False umbilicus usually sealed. Operculum and animal unknown.

*Measurements (mm.)*—

length width no. whorls

58.0	43.5	7	large; off Brisbane, Queensland
42.0	33.2	6	average; Southport, Queensland
41.2	33.0	6	average; Southport, Queensland
34.5	26.1	6	small; off Moreton Id., Queensland
33.5	28.0	-	holotype? Nat. Mus. Vict. no. F666
25.0	17.0	6	holotype (fide Tenison-Woods)

*Synonymy*—

1879 *Cassis nana* Tenison-Woods, Proc. Linn. Soc. New South Wales, vol. 4, p. 108, Moreton Island, [Brisbane, Queensland, Australia]; 1899, Hedley, *ibid.*, vol. 24, p. 434, fig. 6; 1934, Wrigley, Proc. Mal. Soc. London, vol. 21, p. 109.

1927 *Nannocassis nana* (Tenison-Woods), Iredale, Records Australian Mus., vol. 15, p. 328; 1959, Allan, Australian Shells, revised ed., Georgian House, p. 119, text fig. 26-9.

*Types*—The type locality is Moreton Island, near Brisbane, Queensland, Australia. According to Hedley, 1899, p. 434, the holotype collected by Mr. C. Coxen is in the Queensland Museum.

*Records*—All Australia: QUEENSLAND: beach at Frazer Id. (Joy Kerslake, ANSP); Noosa Heads (Joy Kerslake, ANSP); trawled off Caloundra (Joy Kerslake, ANSP); 120 fms. off Moreton Id., Brisbane (A. R. Whitworth, ANSP); 30 fms.,

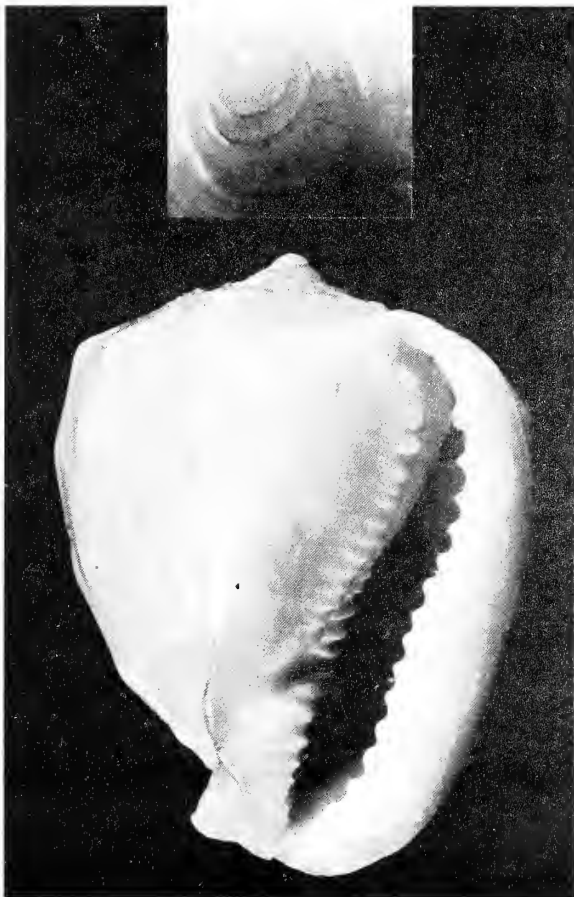


Plate 39. *Cassis (Hypocassis) nana* Tenison-Woods, 1879. Holotype no. F 666, National Museum of Victoria, Queensland, Australia. 33 mm. Enlarged nuclear whorls are from a Caloundra specimen.



off Southport (T. A. Garrard and T. C. Marshall, ANSP; MCZ); 28 fms. off Coolumb, Brisbane (A. Bannah, ANSP). NEW SOUTH WALES: mouth of the Richmond River, Ballina, (Hedley, 1899, p. 434); off Evans Head (Val Manks, AMNH); Nambucca and Trial Bay (both Aust. Mus.).

*Fossil records*—None reported.

### *Cassis torva* (Iredale, 1927)

(Pl. 40)

*Range*—Tertiary of Queensland, Australia.

*Remarks*—This is a very distinct fossil species which shows a closer resemblance to *Cassis fimbriata* than to the small *nana*. The holotype in the Australian Museum (C. 53259) is 57 (not 67) mm. in length and 38 mm. in width. Mrs. L. M. Currey possesses a specimen from Caloundra. It is 45 mm. in length.

#### *Synonymy*—

1927 *Nannocassis torva* Iredale, Records Australian Mus., Sydney, vol. 15, p. 329 (Caloundra, South Queensland), brief mention only; 1927, The Australian Zoologist, Sydney, vol. 4, p. 335, pl. 46, fig. 7.

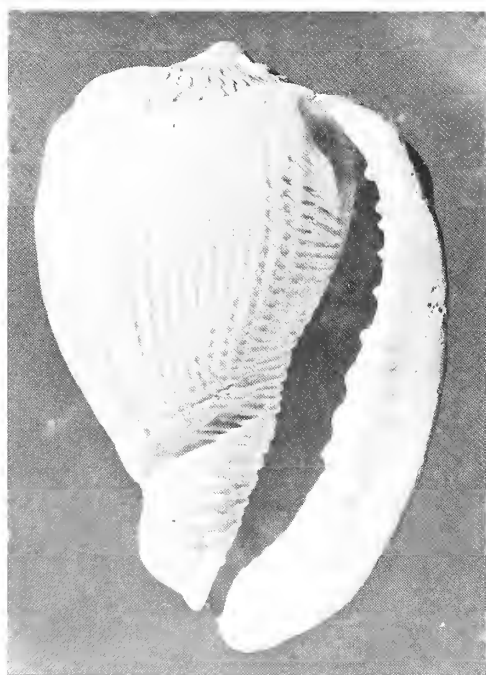


Plate 40. *Cassis (Hypocassis) torva* (Iredale, 1927). Holotype from Tertiary of Caloundra, Queensland, Australia. Australian Museum no. C. 53259.

### *Cassis textilis* Tate, 1882

(Pl. 41)

*Range*—Oligocene of Victoria, Australia.

*Remarks*—I have not seen specimens of this species, but from the description of the small, sub-globose nucleus and the shape of the rather flattened siphonal canal, I am inclined to ally it to the Recent *nana* Tenison-Woods of Queensland and also to *fimbriata* Quoy and Gaimard of the southern coasts of Australia. The last whorl bears spiral threads as well as three rows of tubercles. The original description reads:

“Shell stout, ovate, ventricose, with a short conic spire ending in a small sub-globose pullus, [nucleus] the tip reverted and immersed. Whorls five, excluding pullus, with varices at successive intervals of about two-thirds of a whorl, ornamented with numerous spiral threads crossed by folds of growth, wrinkled at the suture. Last whorl bearing on the superior angle a row of nine nodular tubercles, and on the medial portion two other rows equi-distantly placed, the tubercles of which are smaller, much more so are those of the anterior row. Posterior area concavely sloping backward to the suture.

“Outer lip thickened, margin plain. Columellar callus dentate; columella very tortuous beneath the callus, canal recurved. Length, 45; breadth of last whorl, 32; height, 29; length of aperture, 31 mm.”

#### *Synonymy*—

1882 *Cassis textile* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 5, p. 45; 1889, Tate, *loc. cit.*, vol. 11, p. 165, pl. 7, fig. 11 (River Murray cliffs near Morgan, Cheltenham, Port Philip Bay).  
1903 *Cassis textilis* Tate, Cossmann, Essais de Paléoconchologie Comparée, vol. 5, p. 125 (Oligocene).

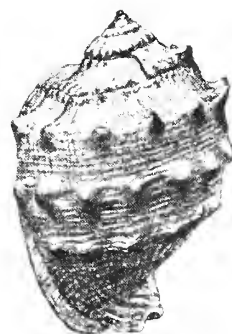


Plate 41. *Cassis (Hypocassis) textilis* Tate, 1882. Oligocene of Victoria, Australia. Length: 45 mm. (from Tate, 1889, pl. 7, fig. 11).

### Genus *Cypraeacassis* Stutchbury, 1837

The four living species in this genus are characterized by oblong, rather heavy shells, with predominantly orange and chocolate-brown pigmentation, numerous fine teeth on the columella, absence of former varices, and a large, translucent apex of 4 or 5 bulimoid whorls. The soft parts are usually orange in color. The operculum is very small, paucispiral, oval, and may be lost in adults. The eyes are located on the tentacles, about  $\frac{1}{3}$  from the base. The tentacles have a small, circular black pigment ring near the distal end.

The subgenus *Levenia* of dubious value was erected by Gray for the species *coarctata* Gray. It differs only in having the upper part of the outer lip reflected inwardly.

### Subgenus *Cypraeacassis* Stutchbury, 1837

Type: *Cypraeacassis rufa* Linné, 1758

There are only three living species in the typical subgenus. The smallest species, *C. testiculus* (Linné) is common to both sides of the tropical Atlantic, and is evidently a survivor of an abundant line of similar *Cypraeacassis* from the Miocene and Pliocene of the Mediterranean area. The *C. tenuis* (Wood) of the Eastern Pacific is possibly an offshoot of the Indo-Pacific *C. rufa* (Linné), probably during the early Pleistocene. The latter species has Miocene relatives in East Africa.

### Synonymy —

1837 *Cypraeacassis* Stutchbury, Magazine Natural History (Charlesworth), new series, vol. 1, p. 214 (type by original designation: *Buccinum rufum* Linn.).

1903 *Cypraeacassis* Cossmann, Essais de Paléoconchologie Comparée, Paris, vol. 5, p. 129. Emendation for *Cypraeacassis* Stutchbury, 1837.

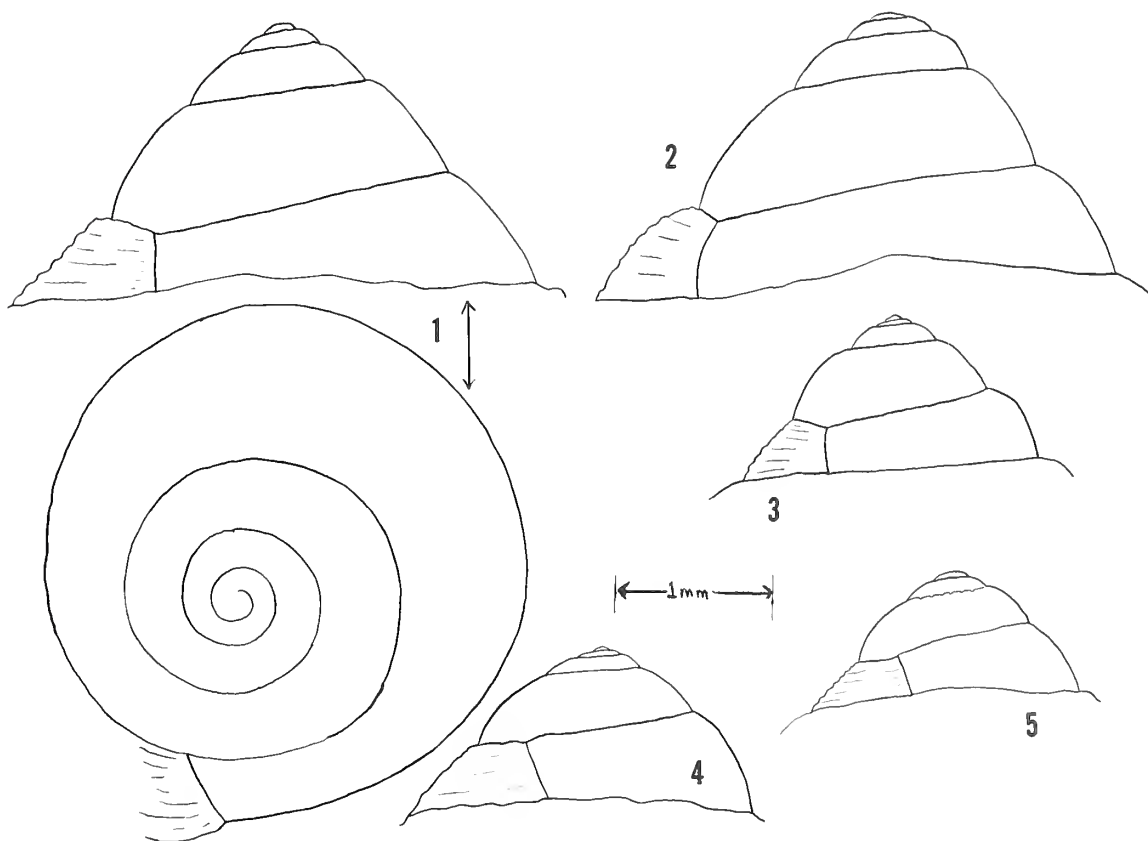


Plate 42. Nuclear whorls of *Cypraeacassis*. Fig. 1, *rufa* (Linné). 2, *tenuis* (Wood). 3, *coarctata* (Sowerby). 4, *testiculus*

(Linné) from the Miocene of Santo Domingo. 5, *testiculus* (Linné) from the Recent of Brazil.



Plate 43. World distribution of the species of *Cypraeccassis*.  
 1, *rufa* (Linné); 2, *tenuis* (Wood); 3, *coarctata* (Sowerby);

4, *testiculus testiculus* (Linné); 4a, *testiculus* subspecies  
*senegalica* (Gmelin).

**Cypraeacassis rufa (Linne, 1758)**

(Pl. 3, fig. 10; pl. 4, figs. 10-12; pls. 44-46)

*Range*—East Africa to eastern Polynesia.

*Remarks*—This well-known species has a wide distribution but is abundant only at the extreme ends of its range, in East Africa and the Line Islands of eastern Polynesia. It is rare in some central areas, such as the Ryukyu Islands, the Philippines, Indonesia and northeastern Australia. It would appear that it is dying out in the middle of its range. In central East Africa it is collected in large numbers and shipped to Italy where cameos are made from the shell. It is the only living Indo-Pacific species in the genus *Cypraeacassis*. Its nearest relative is *C. tenuis* (Wood, 1828) of the tropical Eastern Pacific.

Mr. John F. Spry of Tanganyika writes me that *rufa* apparently preys on the local short-spined sea urchins.

*Habitat*—*C. rufa* is a shallow water species living from the intertidal area to a depth of about 6 feet below low tide mark. It generally lives in fairly sheltered areas where the bottom is of coarse coral sand and algae near coral reef areas.

*Description*—Adult shell 64 to 185 mm. (2-1/2 to 7-1/2 inches) in length, ovate, solid, usually heavy, with 3 or 4 rows of rounded knobs on the dorsum, and with a glossy, orange and brownish red parietal area. Nuclear whorls 5, bulimoid, smoothish, set at an angle of about 20 degrees off the axis of the adult shell; with the first 3 whorls colored whitish tan and the last two reddish brown. The last nuclear whorl has a minute varix. First 3 or 4 post-nuclear whorls with numerous, crowded, fine, irregular spiral threads and cords which become larger and coarser in the last whorl. No former varices in the spire. Body whorl with 3 spiral rows of 6 to 9 fairly large round low, smoothish knobs. Below these is one row of 8 to 12 smaller, axially elongated plicae, and, at the base of the whorl, are 2 rows

of 10 to 14 long, narrow, white, raised bars. Between the spiral rows of knobs there are 2 to 3 spiral cords bearing very small, wart-like, numerous beads. Color of shell reddish or orange-brown with white or grayish pink maculations. Outer lip thin or very thick, glossy, and colored cream and with 7 to 9 broad or paired bars of darker orange-brown. Inside of outer lip with 14 to 21 short or long, raised, white teeth. Parietal wall heavily glazed, rounded, with 5 diffused, broad bands of darker orange-brown. Inner lip with numerous, fine, long, spiral, whitish lirae over a dark-brown patch. Within the aperture and on the columellar wall is an axial swelling bearing 5 to 12 larger whitish teeth. True umbilicus narrow but deep; false umbilicus slightly open or nearly sealed. Operculum chitinous, oval, thick, with concentric growth lines, and proportionately very small (about one tenth the length of the aperture).

*Measurements (mm.)—*

length	width	no. whorls	
185.0	135.0	8	large; Madagascar
161.0	126.0	8	large; Zanzibar
125.0	95.0	9	average; Chagos Archip.
64.0	43.5	8	small; Moluccas

*Synonymy—*

- 1758 *Buccinum rufum* Linné, Systema naturae, ed. 10, p. 736, no. 385 (in Oceano Americano [erroneous]). Refers to Rumphius, pl. 23, fig. B; Gualtieri, pl. 40, fig. F; and others; 1767, Linné, ed. 12, p. 1198, no. 446; 1956, Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, pp. 177-178.
- 1778 *Buccinum pullum* Born, Test. Mus. Caes. Vindob., p. 236; refers to Lister, pl. 1007, fig. 71.
- [1786 *Cassides chartoprates* Meuschen, Mus. Geversianum, Rotterdam, p. 394, nos. 1299-1301. Non-binomial].
- 1791 *Buccinum ventricosum* Gmelin, Systema naturae, ed. 13, p. 3476, no. 25 (no locality); refers to Lister, pl. 1007, fig. 71, a young specimen.



Plate 44. Operculum of *Cypraeacassis rufa* (Linné). Mahé, Seychelles. R. Winekworth, coll. Shell, 152 mm.; operculum 8.2 mm. Left: outer side; right: inner, attachment side.

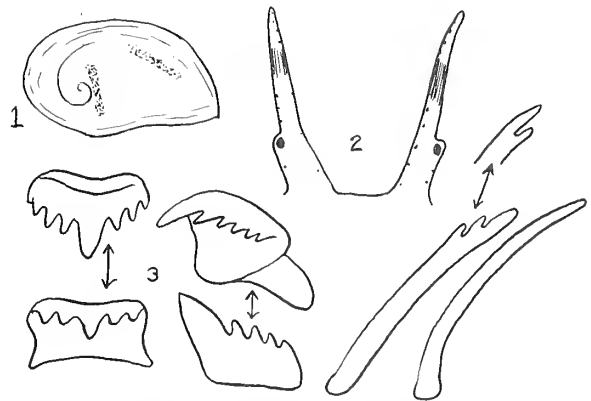


Plate 45. *Cypraeacassis rufa* (Linné), young male from Zanzibar. Fig. 1, attachment side of operculum, 4 mm. in length. Fig. 2, tentacles. Fig. 3, various views of radular teeth, showing variation in the number of denticles.



- 1791 *Buccinum pennatum* Gmelin, loc. cit., p. 3476, no. 21 (in India); refers to Rumphius, pl. 23, fig. C, and Conchyl.-Cab., vol. 2, figs. 372, 373, a young specimen.
- 1792 *Cassidea pennata* Bruguière, Encyclop. Méthodique, Vers, vol. 1, no. 2, p. 427, no. 11 (Amboina); refers to Lister, pl. 1007, fig. 71; and others.
- 1792 *Cassidea rufa* Linné, Bruguière, loc. cit., p. 433, no. 16.
- [1797 *Cassida ost-tauri* Humphrey, Museum Calonnianum, p. 19. Non-binomial].
- 1798 *Cassis rufum* Gmelin, Röding, Mus. Boltinianum, Hamburg, pt. 2, p. 28, no. 349 (no locality); refers to Conchyl.-Cab., vol. 2, fig. 341 and Knorr, pt. 2, pl. 9, fig. 2.
- 1798 *Cassis rufescens* Röding, loc. cit., p. 29, no. 350 (no locality).
- 1798 *Cassis pennata* Gmelin, Röding, loc. cit., p. 29, no. 359 (no locality).
- 1798 *Cassis tuberosa* Röding, loc. cit., p. 28, no. 343 (in part by referring to Knorr, pt. 6, pl. 18, fig. 1; non Linné, 1758).
- 1811 *Cassis labiata* Perry, Conchology, London, Appendix, pl. 33, no. 4 (Cape of Good Hope and African Seas). Not *Cassidea labiata* Perry, 1811.
- 1822 *Cassis rufa* Linné, Lamarck, Anim. sans Vert., vol. 7, p. 224, no. 13; 1835, Kiener, Coq. Vivantes, Paris, vol. 8, Cassidaire, pl. 7, figs. 12, 13.
- 1837 *Cypracassis rufa* Linné, Stutchbury, Mag. Nat. Hist. (Charlesworth), vol. 1, p. 214, figs. 22a, b; 1927, Iredale, Records Australian Museum, vol. 15, p. 330.
- 1935 *Cassis (Cypracassis) rufa* Linné, Bayer, Zoologische Mededeelingen, Leiden, vol. 18, p. 96.

**Types**—There is a specimen of this well-known species in the Linnaean collection in London which may be the type. Linné's type locality of "In Oceano Americano" is erroneous. We designate Amboina, Indonesia, as the type locality.

**Nomenclature**—Although seven other names have been given to this species, the identity and use of the name *rufa* has been unanimous among workers since Deshayes' (1835) time. The young form was thought to be another species (*pennata* Gmelin and *pulla* Born) by some early workers, such as Bruguière.

**Records**—SOUTH AFRICA: 10 to 20 feet, off Durban, Natal (P. Elston, *in litt.*, 1962); north Zululand coast (Helen Boswell, *in litt.*, 1962). MOZAMBIQUE: Lourenco Marques (P. Elston, *in litt.*, 1962); Bazaruto Bay (MCZ); Port Amelia (USNM). TANGANYIKA: Sinda Id., off Dar-es-Salaam (R. T. Abbott, USNM); Fungi Yasin; Ras Kankodya; Oyster Bay; Kendiva (all John F. Spry, *in litt.*, 1962). KENYA: Malindi (USNM); Diani Beach, 20 mi. south of Mombasa (R. T. Abbott, USNM). ZANZIBAR: reef flat at Ras Nungwe; 2 mi. north of Kizimkazi; Mnemba Id. (all A. J. Ostheimer, 3rd, ANSP). SOMALIA: 50 mi. north of Obbia (AMNH). MADAGASCAR: Madirokely, Nossi-bé (Madame Caille, ANSP); Nosy Sakatia, Nossi-bé (ANSP Exped., 1960); Ambodifolotra, Ile Ste. Marie (R. W. Foster, MCZ); Tulear (Dautzenberg coll'n., Bruxelles); Mayote Id., Comores (Rijksmus. Leiden). INDIAN OCEAN ISLANDS: Gloriosa Id. (USNM). SEYCHELLES: Mahé (R. Winckworth, BM); Peros Banhos Id., Chagos Archip. (Mauritius Inst.; ANSP); Salomon, Chagos Archip. (Mrs. J. Couacaud, ANSP). MAURITIUS: Arsenel (Mr. J. Couacaud, ANSP); Port Louis (MCZ); Rodriguez (P. Elston, *in litt.*, 1962). MALDIVES: Dandru, Suva Diva (A. Agassiz, MCZ); Nadale Id., Suva Diva (USNM); Hulule Id. (E. A. Smith, 1903, p. 611); Imma Id., North Malé Atoll (R. Robertson, 1964, Inter. Indian Ocean Exped.). COCOS-KEELING: (Gibson-Hill, USNM and Raffles Mus.). INDONESIA: Nias Id., Sumatra; Poeloe Pandjung; Medan; Tjilatjap, Java; Poeloe Tello, Batoe Id.; Amboina; Timor Id.; Waigeo Id. (all Rijksmus. Leiden); South Loloda Ids., west of Halmahera (D. Fairchild, MCZ); Ceram Id. (MCZ); Kangean Id. (Mus. Zool. Bogoriense, fide Butot, *in litt.*). NEW GUINEA: Korido Bay, Soepiori, Schouten Ids. (A. J. Ostheimer, 3rd, ANSP); Mopia; Ile Manasbari (both Dautzenberg coll'n., Bruxelles). BISMARCKS: Kaliai Reef, New Britain Id. (H. Coutourmas, ANSP). AUSTRALIA: Thursday Id. (Geo. Pattison, *in litt.* 1962). RYUKYUS: Okinawa (R. T. Abbott, 1958, ANSP). FORMOSA: Hoko (Kuroda, 1941, p. 104). PHILIPPINES: Siasi Id., Sulu Archip. (USNM). SOLOMONS: Ususue, Ata, Malaita Id. (Rev. J. van der Riet, ANSP); Senga, Choiseul Id. (W. Eyerdam, 1929, AMNH); Vanikoro Id., Santa Cruz Ids. (Aust. Mus.). PALAUS: Pelelieu Id. (A. J. Ostheimer, 3rd, ANSP). FIJI: ?(Nat. Mus. Victoria). TOKELAU: Swain Id., north of Samoa (ANSP). TUAMOTUS: Disappointment Id. (Titian R. Peale, 1834, U.S. Expl. Exped., ANSP); Manahi Id. (J. M. Clements, USNM); Raroia (J. P. E. Morrison, USNM). GILBERT ISLANDS: (B. P. Bish. Mus.). LINE ISLANDS: Baker Id.; Washington Id.; Jarvis Id. (all B. P. Bishop Mus.); Caroline Id. (C. D. Voy, ANSP).

**Fossil records**—None known to me.

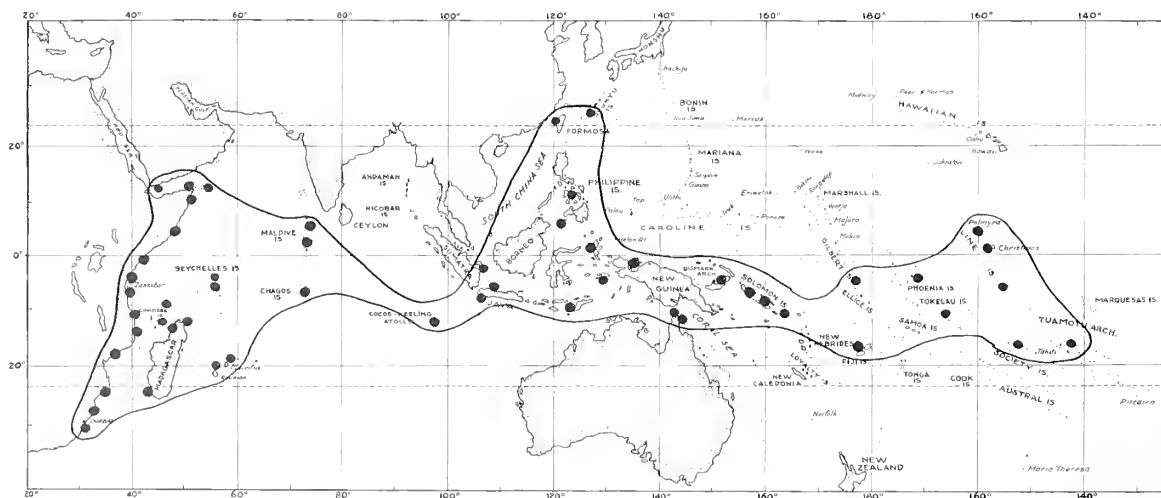


Plate 46. Geographical distribution of *Cypracassis rufa* (Linné).

**Cypraeacassis pustulata (Cox, 1927)**

(Pl. 47, figs. 4-6)

*Range*—Miocene of Pemba Island, East Africa.*Remarks*—This and *C. morus* Cox from the same locality are probably forms of the same species. They show some resemblance to the Recent *Cypraeacassis rufa* Linné.*Synonymy*—1927 *Cassis* (*Cypraeacassis*) *pustulata* Cox, Report on the Palaeontology of the Zanzibar Protectorate, p. 26, pl. 9, figs. 11a, b. (Pemba station 68).1927 *Cassis* (*Cypraeacassis*?) *morus* Cox, *loc. cit.*, p. 27, pl. 9, figs. 10a, b. (Pemba station 68).**Cypraeacassis testiculus (Linné, 1758)**

Today, this species is living in tropical Atlantic waters both in the Eastern and Western Atlantic. Pliocene representatives from Italy, such as *Cypraeacassis cypraeiformis* (Borson, 1820) and *C. pseudocrumena* (Orbigny, 1852) are similar but certainly not conspecific with the living *testiculus*. However, Miocene specimens from the West Indies (Santo Domingo, Wm. Gabb, 1873) are almost inseparable from today's *testiculus*, which suggests that the original stock of *testiculus* was American. In Europe there are many Pliocene forms, some of which closely resemble the extremely plicate form "*crumena*"

of the Recent West African, Cape Verde, Ascension, and St. Helena Islands. The extreme variation in the Recent Eastern Atlantic colonies seem to have been contributed by European Pliocene and Pleistocene stocks.

Unfortunately, the Recent *testiculus* from the Eastern and Western Atlantic are not clearly separable, and this state is evident from the way former workers have treated this taxon. Bayer (1935) and Salmon (1948) considered them different species; Clench and Abbott (1943) considered them the same and reduced "*crumena*" to the status of a forma. I have since examined numerous specimens from both sides of the Atlantic, and now believe they should be treated as subspecies. It should be pointed out that although many West African specimens are characteristically large, devoid of spiral sculpturing, and with very large smooth, axial plications, one may find in the same colonies specimens which are identical to West Indian forms. Certain Caribbean specimens may have similar but much smaller plicae. My subspecies separation is admittedly weak, although a practical one. The earliest name for the Eastern Atlantic subspecies is *senegalica* (Gmelin, 1791) with *crumena* (Bruguière, 1792) a synonym. If one were to apply a name to the weakly plicate Caribbean form, the earliest name is *bicincta* (Bayer, 1935). *Cassis mitella polonica* Röding, 1798, is a synonym of *testiculus* Linné.

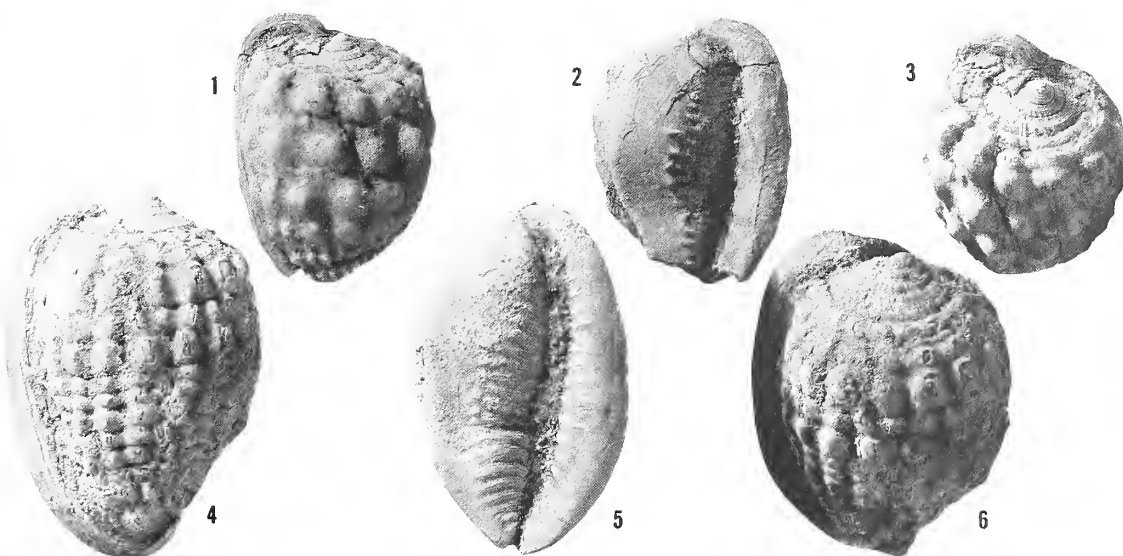


Plate 47. Miocene *Cypraeacassis* from Pemba Island, East Africa. Figs. 1-3, holotype of *C. morus* (Cox, 1927). 36 mm. Figs. 4-6, holotype of *C. pustulata* (Cox, 1927). 50 mm. All

photos courtesy of T. Nuttall, British Museum (Natural History).

***Cypraeacassis testiculus***  
***subspecies testiculus* (Linné, 1758)**  
 (Pl. 4, fig. 9; pl. 48)

**Range**—Bermuda, southeast Florida, the Caribbean and south to Brazil. Tertiary of the Caribbean.

**Remarks**—This is a moderately common shallow-water species ranging in size from 1 to 3-1/4 inches, and characterized by 13 to 17 spiral rows of numerous, small, usually elongate beads or short, axial plicae, and by a heavily glazed, low, rounded parietal shield. The latter is white above and with orange stain on the lower third. The shell is usually brightly colored with orange-brown maculations, zigzag stripes or rows of arrow-shaped spots.

Clench and Abbott, (1943, p. 2), report that *testiculus* in the West Indies "is found usually around reef water where it can migrate from the deeper water to lay its eggs in the warmer and shallower regions. The eggs are the size of swollen grains of rice and are laid under small rocks or under large broken shells in greenish brown clusters of a hundred or so capsules."

I have revised and added to the synonymy of this species and its Eastern Atlantic subspecies *senegalica* (Gmelin, 1791). Clench and Abbott (1943) used the younger name, *crumena* (Bruguère, 1792).

In the fossil state, *C. testiculus* occurs in the Pleistocene of Barbados and Cuba, and, according to Gabb, Maury and Pilsbry, in the Miocene of the Dominican Republic (Weisbord, 1962, p. 254).

**Types**—Linnaeus' type, according to Dodge (1956, p. 182) is in the Linnaean Society collection in London. The type locality is Jamaica, British West Indies.

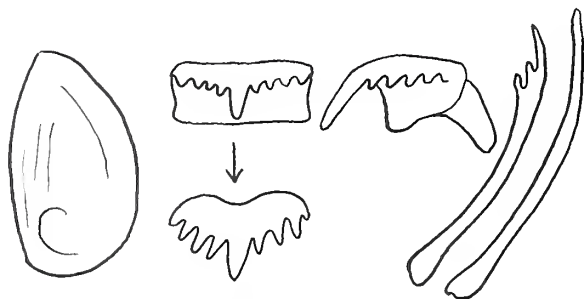


Plate 48. *Cypraeacassis testiculus* (Linné). Operculum from young specimen, and radulae from adult female from Yuma, Haiti.

**Synonymy—**

- 1758 *Buccinum testiculus* Linné, Systema naturae, ed. 10, p. 736, no. 387 (Ad Jamaican); refers to Rumphius, pl. 23, fig. 3; Gualtieri, pl. 39, fig. C. (selected type figure by Clench and Abbott, 1943, p. 2); 1767, Linné, ed. 12, p. 1199, no. 449; 1956, Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, pp. 181-182.
- 1798 *Cassis pileolus* Röding, Mus. Boltenianum, Hamburg, pt. 2, p. 29, no. 356 (no locality); refers to Conchyl.-Cab., vol. 2, figs. 375, 376; Knorr, pt. 4, pl. 6, fig. 1.
- 1837 *Cypraeacassis testiculus* Brug., Stutchbury, Mag. of Nat. Hist. (Charlesworth ed.), new series, vol. 1, p. 216, 472, fig. 53.
- 1917 *Cassis (Cypraeacassis) testiculus* (Linnaeus), Maury, Bull. Amer. Paleont., vol. 5, no. 29, p. 275; 1922, Maury, loc. cit., vol. 9, no. 38, p. 118; 1935, Bayer, Zoolog. Mededeel., vol. 18, p. 97.
- 1935 *Cassis testiculus* var. *bicincta* Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 97, fig. 1.
- 1943 *Cypraeacassis testiculus* Linné, Clench and Abbott, Johnsonia, vol. 1, no. 9, pp. 1-3, pl. 1, pl. 3, figs. 1-3; 1961, Warmke and Abbott, Caribbean Seashells, Livingston Co., Narberth, Pa., p. 99, pl. 3, fig. C, p. 320 (distribution map); 1962, Weisbord, Bull. Amer. Paleont., vol. 42, pp. 252-254, pl. 23, figs. 11-14.

***Cypraeacassis testiculus***  
***subspecies senegalica* (Gmelin, 1791)**  
 (Pl. 50)

**Range**—West coast of Africa from Senegal to Angola, and the offshore islands of Cape Verde, Ascension and St. Helena.

**Remarks**—Some few specimens are very similar to the typical *testiculus* from the Caribbean, but most are larger (3 to 4 inches in length),



Plate 49. Geographical distribution of *Cypraeacassis testiculus testiculus* (Linné) in the Western Atlantic (1) and *testiculus* subspecies *senegalica* (Gmelin) in the Eastern Atlantic (2).



smoother, a duller color, and bear 5 to 7 quite large, smooth, axial plications on the shoulder of the last whorl. It is very variable in sculpture.

*Measurements (mm.)—*

length	width	no. whorls	
97.0	62.0	7+	large; St. Helena
93.9	57.2	7+	type of <i>crumena</i> Brug.
90.5	54.8	8+	large; St. Helena
82.8	51.3	7+	average; St. Helena

*Synonymy—*

- [1757 *Purpura* 7. "Le Fasin", Adanson, Hist. Nat. Sénégal, Coquillages, p. 111, pl. 7, fig. 7; 1942, Fischer-Piette, Jour. de Conchyl., Paris, vol. 85, p. 208, pl. 7, fig. 5 (photo of Adanson's specimen).] Non-binomial.
- 1791 *Buccinum senegalicum* Gmelin, Systema naturae, ed. 13, p. 3477, no. 31 (ad Senegal); refers to Adanson, pl. 7, fig. 7.
- 1791 *Buccinum plicatum* Gmelin, loc. cit., p. 3472, no. 10; refers to Conchyl.-Cab., vol. 2, figs. 379 and 380; Lister, pl. 1002, fig. 67; and others; 1798, Röding, Mus. Boltenianum, pt. 2, p. 29; 1817, Dillwyn, Descript. Cat., London, vol. 2, p. 588. Not Linné, 1758.
- 1792 *Cassidea crumena* Bruguière, Encyclopédie Méthodique, Vers, vol. 1, p. 428, no. 12 (Ascension); refers to Lister, pl. 1002, fig. 67; Conchyl.-Cab., vol. 2, figs. 379 and 380; 1816, Lamarck, loc. cit., pl. 406, Le Liste, p. 3.
- 1835 *Cassis testiculus* Brug., var., Kiener, Coq. Vivantes, Paris, Casque, p. 21, pl. 4, fig. 7.
- 1884 *Cassis testiculus* var. *crumena* Brug., Tausch, Jahrb. Dents. Malak. Ges., vol. 9, pp. 183-184.
- 1935 *Cassis* (*Cypraeacassis*) *crumena* (Bruguière), Bayer, Zoologische Mededeelingen, Leiden, vol. 18, p. 96; 1964, Alvarado, Bol. R. Soc. Español. Hist. Nat. (Biol.), vol. 62, p. 270 (Annobon, Spanish Guinea).
- 1942 *Cassis testiculus* L. var. *senegalica* Gmelin, Fischer-Piette, Jour. de Conchyl., vol. 85, p. 208, pl. 5, fig. 5 (selected type); 1950, Nicklés, Manuels Ouest-Africains, Paris, vol. 2, p. 85, fig. 130.
- 1943 *Cypraeacassis testiculus* form *crumena* Bruguière, Clench and Abbott, Johnsonia, vol. 1, no. 9, p. 3 (in part, due to Cape Verde Ids. record).
- 1948 *Cassis* (*Cypraeacassis*) *senegalica* var. *mamillata* Salmon, Jour. de Conchyl., Paris, vol. 88, p. 159, fig. 1 (Afrique occidentale).

*Types*—The type locality of *senegalica* is Senegal, West Africa. The type, Adanson's specimen, is in the Museum Nat. Hist. in Paris. The specimen illustrated by Kiener is possibly Bruguière's type of *crumena* and is in the Museum de Genève, Switzerland. Salmon's variety or form, *mamillata* is in the Museum Nat. Hist. Paris.

*Records*—Senegal (Nicklés, 1950, p. 85, fig. 130). Bissau, Portuguese Guinea (Nobre, 1909, Suppl. 2, p. 27). Santiago, Cape Verde Islands (MCZ). Cabo de San Juan, Spanish Guinea (Carnegie Mus.). Ascension (MCZ). St. Helena (Th. Mortensen, 1930, Zool. Mus. Copenhagen). Sao Thomé Id.; Gaboon and French Congo (Nicklés, 1950, p. 85). Port Gentil and Pointe Noire, Congo (Nicklés, 1952, vol. 92, p. 147). Angola (Nobre, 1909, Suppl. 2, p. 27).

*Fossil records*—Madeira (Pleistocene?) (Mayer, 1864, in Hartung, Geol. Besch. Madeira u. Porto-Santo, p. 254).

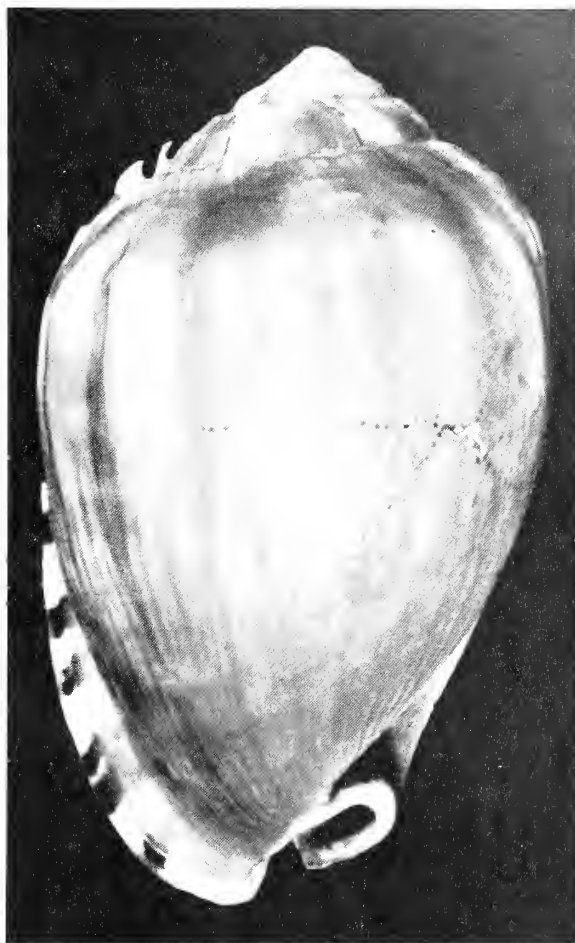


Plate 50. *Cypraeacassis testiculus* subspecies *senegalica* (Gmelin, 1791). [Eastern Atlantic]. Holotype of *Cassis crumena* Bruguière. Mus. Geneva. 93.9 mm. in length. The pinholes are due to a boring sponge growth.



### European Tertiary *Cypraeacassis*

A number of fossil species occur in the Tertiary of Europe which evidently represent the stock of Recent *Cypraeacassis testiculus* (Linné) of West Africa and the Caribbean. A fossil specimen of *Cypraeacassis* is in the Paris Museum with a specific name of *conglobata* Brocchi, but that name was used only in connection with a buccinid or nassariid species in 1814 by Brocchi.

#### *Cypraeacassis subtesticulus* (Orbigny, 1852)

*Range*—Lower and Middle Miocene of Europe

##### *Synonymy*—

- 1817 *Cassis plicata* DeFrance, Dictionnaire Sciences Naturelles, Paris, vol. 7, p. 210 (Plaisantin, Italy). Non Linné, 1758. Types fig'd. in Sacco, 1908, Palaeontologia Universalis, pl. 163a.
- 1829 *Cassis marginatus* de Serres, Geogn. Terr. Tert., p. 119, pl. 2, figs. 13, 14. Non Borson, 1820, which is a *Cymatium*.
- 1840 *Cassis testiculus* Lam., Grateloup, Conchyliologie Fossile des Terrains Tert. bassin l'Adour, vol. 1, pl. 1, fig. 13.
- 1852 *Cassis subtesticulus* Orbigny, Prodrôme Paleont. Strat. Universelles, Paris, vol. 3, p. 90, no. 1669. Refers to Grateloup, pl. 1, fig. 13.
- 1890 *Cassis (Cassidea) marginata* vars. *ornata*, *initialis* and *savonensis* Sacco, I Moll. Terr. Terz. Piemonte, pt. 7, pp. 23-24, pl. 1, figs. 19, 20.
- 1890 *Cassis (Cassidea) protesticulus* Sacco, loc. cit., p. 24, pl. 1, fig. 21 (Piacenziano: Fornaci).
- 1891 *Cassidea crumena* var. *atuberculata* Sacco, I Moll. Terr. Terz. Piemonte, pt. 10, p. 3 (Astiano).
- 1908 *Cypraeacassis marginata* de Serres, Sacco, Palaeontologia Universalis, pl. 163a. Sacco's vars. *ornata*, *savonensis* and *initialis* fig'd.
- 1908 *Cassis ruscensis* Fontannes, Sacco, Palaeontologia Universalis, p. 163a (Rhône, France; Pliocene). I cannot locate Fontannes' original description.
- 1963 *Cypraeacassis subtesticulus* Orbigny, Glibert, Institut Royal Sci. Nat. Belgique, mémoires, ser. 2, fasc. 73, p. 112.

#### *Cypraeacassis cypraeiformis* (Borson, 1820) (Pl. 51)

*Range*—Middle Miocene of Europe.

##### *Synonymy*—

- 1820 *Cassis cypraeiformis* Borson, Memorie della Accademia di Torino, vol. 25, p. 229, pl. 1, fig. 20 (Colli torinesi).
- 1890 *Cassidea cypraeiformis* Borson, Sacco, I Molluschi Terr. Terz. Piemonte, pt. 7, p. 19, pl. 1, fig. 14 (with vars. *crassilabiata*, *tuberculosa* and *reticulosa* all Sacco, 1890).
- 1951 *Cassis cypraeiformis* Bors., Friedberg, Mieczaki Miocenskie Krakow, pt. Gasteropoda, p. 113 (Korytnica, Poland).
- 1963 *Cypraeacassis cypraeiformis* Borson, Glibert, Institut Royal Sci. Nat. Belgique, ser. 2, fasc. 73, p. 112.

#### *Cypraeacassis pseudocrumena* (Sacco, 1890) (Pl. 52)

*Range*—Pliocene of Italy and France.

*Remarks*—This form is so close to the Recent specimens of *testiculus* from West Africa that it probably should be considered a subspecies or synonym. Orbigny's original name *pseudocrumena* was not validated until 1890 by Sacco.

##### *Synonymy*—

- 1852 *Cassis pseudocrumena* Orbigny, Prodrôme Paleont. Strat. Universelle, Paris, vol. 3, p. 177, no. 238. *Nomen nudum*.
- 1890 *Cassidea crumena* var. *pseudocrumena* "Orbigny", Sacco, I Moll. Terr. Terz. Piemonte, pt. 7, p. 21, pl. 1, fig. 17 (with subvars. *multinodosa*, *ornata*, *venusta*, *testiculoides*, pl. 1, fig. 18, *raritytuberculata*, *miocenica* all Sacco, 1890).
- 1963 *Cypraeacassis pseudocrumena* Orbigny, Glibert, Institut Royal Sci. Nat. Belgique, mémoires, ser. 2, fasc. 73, p. 112.

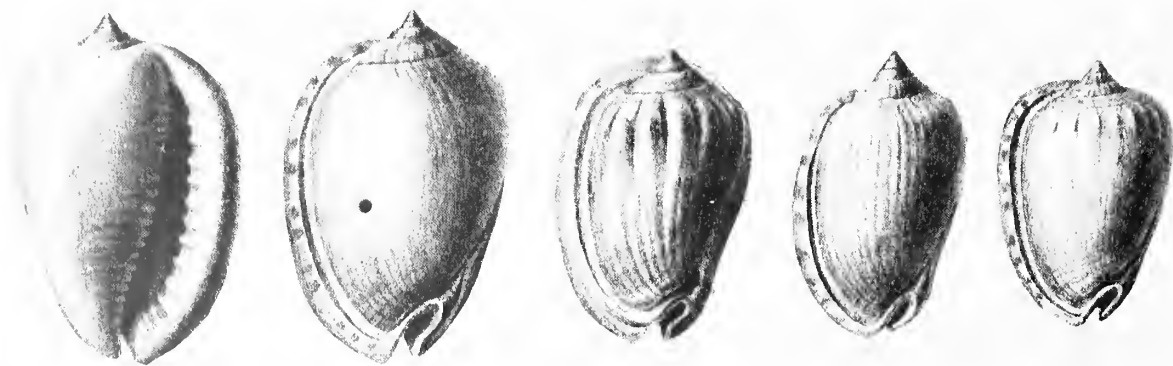


Plate 51. Variation in sculpturing in the European Miocene *Cypraeacassis cypraeiformis* (Borson, 1820). 35 to 65 mm. in

length. (all from Hoernes and Auinger, 1884, pl. 17, figs. 7-10).



Plate 52. *Cypraeacassis pseudocrumena* (Orbigny, 1852). Tertiary of Europe. Left fig.: forma *multinodosa* Sacco, 1890. 50 mm. Right fig.: forma *ornata* Sacco, 1890. 52 mm. (both from Sacco, 1904, pl. 20, figs. 3 and 4).

### *Cypraeacassis subcrumena* (Orbigny, 1852)

Range—Lower Miocene of Europe.

#### Synonymy —

- 1840 *Cassidaria crumena* var. Grateloup, Conchyliologie Fossile des Terrains Tert. bassin l'Adour, vol. 1, pl. 1, figs. 2, 3.  
 1852 *Cassis subcrumena* Orbigny, Prodrome Paléont. Strat. Universelle, Paris, vol. 3, p. 90, no. 1665. Refers to Grateloup, pl. 1, figs. 2, 3.  
 1924 *Cypraeacassis subcrumena* d'Orb., Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 87, pl. 12, fig. 4, 5.

### *Cypraeacassis tenuis* (Wood, 1828)

(Pl. 4, fig. 7)

Range—Lower California to Clipperton, the Galapagos Islands, and to Ecuador.

**Remarks**—This is the largest and least common of the two Eastern Pacific members of this genus. Its 4- to 5-inch shell is characterized by its relatively thin walls, by the well-developed posterior siphonal canal, by its last varix being reflected backward along its entire length, and by the presence of dark-brown stains between the whitish teeth on the lower part of the columella. Its posterior siphonal canal is similar to that of *Cassis tessellata* (Gmelin) from West Africa, but the latter species has strong former varices in the spire, and a white peristome. In some areas, such as La Paz, Mexico, and the Galapagos, shells are cast on the beach after storms. No authentic records exist for the mainland of Ecuador.

Hertlein and Allison (1960, Veliger, vol. 3, p. 14) found dead specimens on the beaches of

Clipperton Island, and surmised that this species was “possibly responsible for predation on the common sea urchin, *Tripneustes gratilla*, many tests of which bear single small perforations on side or upper surface.”

**Description**—Adult shell 68 to 125 mm. (about 2-3/4 to 5 inches) in length, thin-shelled but strong, roundly elongate, with a broad, thin, parietal shield, with spiral rows of small-knobbed cords on the shoulder, and colored tan with light-brown flecks and maculations. Nuclear whorls 4, relatively large, bulimoid, smooth, the first 2 whitish, the last 2 brownish. First 2 post-nuclear whorls smooth, except for numerous, microscopic, spiral threads. Body whorl with 10 to 13 low, flattish, irregularly-sized spiral cords of which the uppermost bears 7 to 9 moderately large, rather evenly-sized, low, rounded knobs. There may be 2 or 3 similar rows of smaller knobs below. In some specimens the very low cords on the base of the shell bear numerous, elongate, raised, whitish, axial bars. Parietal shield well-developed, except on the parietal wall where the spiral rows of brown squares show through the weak, clear glaze. Posterior siphonal canal well-developed and fluted. Spire may have 1 or 2 extremely weak former varices which are more like “resting stages” in the growth of the whorls. Outer lip broad, reflected, glossy, cream with about 6 mauve bands, and with about 20 to 25 white, spiral teeth which may occur in pairs and have dark-brown between the ones at the lower third of the outer lip. Columella dark-brown and with 10 to 14 strong, white, spiral teeth. True and false umbilicus open and deep. Periostracum very thin, light-brown and usually worn away in adults. Operculum very small, oblong-oval, horny, brown and rough.

#### Measurements (mm.)—

length	width	no. whorls	
125.0	70.0	6+	large; Galapagos
115.0	58.0	9	average; Galapagos
91.2	54.7	7+	holotype of <i>massenae</i> Kiener
68.5	41.0	7+	small; Galapagos

#### Synonymy —

- 1828 *Cassis tennis* Wood, Supplement to Index Testac., London, p. 33, pl. 4, fig. 4 (no locality); 1848, Reeve, Conch. Icon., vol. 5, Cassis, pl. 6, fig. 13a-c. (Galapagos; 6 fms., sandy mud).  
 1835 *Cassis massenae* Kiener, Coquilles Vivantes, Paris, vol. 8, Cassis, p. 17, no. 9, pl. 8, fig. 14 (les mers d'Amerique).  
 1932 *Cassis tennis* Gray, Pilsbry and Lowe, Proc. Acad. Nat. Sci. Phila., vol. 84, p. 121.  
 1935 *Cassis* (*Cypraeacassis*) *tenuis* Gray, Bayer, Zoologische Mededelingen, Leiden, vol. 18, p. 97.

- 1958 *Cassis* (*Cypraeacassis*) *tenuis* Wood, Keen, Sea Shells of Tropical West America, Stanford, p. 340, fig. 312.  
1961 cf *Cypraeacassis tenuis* Woodring and Malavassi, Jour. Paleo., vol. 35, no. 3, p. 494, pl. 69, figs. 1, 2.  
1963 *Cypraeacassis tenuis* (Wood), Emerson and Old, Amer. Mus. Novitates, no. 2153, p. 12, fig. 10.

*Types*—Wood's type of *tenuis* has not been located. He gave no locality. We designate La Paz, Mexico, as the restricted type locality. Kienner's type of *massenae* is in the Museum de Genève (1962).

*Records*—MEXICO: Salinas Bay, Carmen Id.; La Paz (both USNM); Espiritu Santo Id., near La Paz (Pilsbry and Lowe, 1932, p. 121); Cape San Lucas (USNM); Tres Marias Ids. (Emerson and Old, 1963, p. 13). GALAPAGOS: Narborough Id. (R. E. Snodgrass, 1899, ANSP); Gardner Bay, Hood Id.; Conway Bay, Indefatigable Id.; Post Office Bay, Charles Id. (all H. A. Pilsbry, Pinchot Exped., 1929, ANSP); Iguana Cove, Albemarle Id. (ANSP); James Id. (USNM); Banks Id. (Stanford Univ.). CLIPPERTON ID.: (Cal. Acad. Sci.). Ecuador (Keen, 1958).

*Fossil records*—PLEISTOCENE: 5-10 meters above sea level, James Bay, James (San Salvador) Id. (Hertlein, 1939, vol. 23, p. 370). Woodring and Malavassi's 1961 Miocene record from Costa Rica is based upon a specimen which I would hesitate to place in the family Cassidae.

[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]

### Subgenus *Levenia* Gray, 1847

Type: *Cypraeacassis coarctata* (Sowerby, 1825)

There is only one species in this subgenus which differs from *Cypraeacassis* only in having the upper third of the outer lip reflected inwardly. The dentition of the aperture is more like that of the West Indian *C. testiculus* than that of the other Eastern Pacific species, *C. tennis*.

#### Synonymy—

1847 *Levenia* Gray, Proc. Zool. Soc. London for 1847, p. 137 (type by monotypy: *Cassia coarctata* Sowerby).

### *Cypraeacassis coarctata* (Sowerby, 1825)

(Pl. 4, fig. 8; pl. 53)

*Range*—Gulf of California to northern Peru.

*Remarks*—This is a moderately common species with a wide, western American geographical distribution. It differs from the only other Eastern Pacific *Cypraeacassis*, *tennis* (Wood), in having a proportionately much heavier shell, in having both the true and false umbilicus almost sealed, in having brown stains between the teeth, in having the upper third of the outer lip pinched in, and in lacking the posterior siphonal canal. This species is reported by Sowerby (1837, p. 369) to have an operculum. Live specimens have a fairly well-developed periostracum.

This species was reported from the Galapagos Islands on the word of Hugh Cuming, but I have never found another record and question its authenticity.

*Habitat*—It is not uncommonly found dead on beaches. It has been dredged at depths of 4 to 6 fathoms; and Dr. Blenn R. Bales (*in litt.*, 1938) reports that he collected several live adults at Acapulco clinging to the sides of rocks between tide marks. Reeve (1848, *Cassia*, sp. 14) reported that Hugh Cuming collected it in a similar habitat.

*Description*—Adult shell 40 to 70 mm. (1-1/2 to 2-3/4 inches) in length, solid, moderately heavy, elongate, with 4 spiral rows of indistinct knobs, with a narrow, posteriorly constricted aperture,

and colored with dark-brown and gray maculations. Nuclear whorls rather large, 3-1/2 to 4, bulimoid, brown to tan, and smooth. Postnuclear whorls 4, with microscopic spiral threads crossed by fine axial growth lines which may form minute beads. Last whorl with 4 spiral rows of 5 or 6 low, indistinct knobs which are less prominent on the lowest cord. True umbilicus usually sealed by a cream and orange extension of the parietal callus. False umbilicus narrow, small, deep, and with whitish orange walls. Outer lip turned inward at the upper third, and flaring outward at the lower third, but not recurved. Inner edge of orange and cream outer lip with 12 to 18 elongate whitish teeth. Parietal wall often glazed thickly with orange-cream. Columella with numerous raised, white spiral teeth. Periostracum moderately thick and brownish, but usually flakes off in dry specimens. Operculum reported to be present.

#### Measurements (mm.)—

length	width	no. whorls	
74.0	—	5+	large; Cleofas Id., Mexico
71.0	40.0	8	large; Sowerby's holotype
70.0	36.5	8	large; Ecuador
67.0	33.5	7+	large; Acapulco
53.5	28.0	8	average; Ecuador
40.0	21.9	7+	small; Mazatlan

#### Synonymy—

1825 *Cassia coarctata* Sowerby, Cat. Shells Tankerville, London, p. 70 (nude), appendix, p. xxi, no. 1826 (New Zealand. . .); 1837, Sowerby, Mag. Nat. Hist. (Charlesworth ed.), new series, vol. 1, p. 367, fig. 28 c (operculum).



Plate 53. *Cypraeacassis (Levenia) coarctata* Sowerby, 1825. [Eastern Pacific]. Holotype. British Museum (Natural History). 71.0 mm. in length.



- 1828 *Buccinum coarctatum* Wood, Supplement to Index Testac., London, p. 33, pl. 4, fig. 5.
- 1832 *Cassis coarctata* Wood, Valenciennes, in Humboldt and Bonpland, Recueil d'Observ. Zool., vol. 2, p. 313 (Acapulco; and Peru).
- 1835 *Cassis coarctatum* Valenciennes, Kiener, Coquilles Vivantes, vol. 8, p. 19, pl. 8, fig. 15 (du Pérou à Acapulco). 1852, C. B. Adams, Ann. Lyceum Nat. Hist., vol. 5, p. 103 [reprint], no. 111 (Panama).
- 1837 *Cypræcassis coarctata* Valenciennes, Stutchbury, Mag. Nat. Hist. (Charlesworth, ed.), new series, vol. 1, p. 216, 471.
- 1848 *Cassis coarctata* Gray, Reeve, Conch. Icon., vol. 5, Cassis, pl. 6, sp. 14; 1924, A. A. Olsson, Nautilus, vol. 37, p. 124; 1932, Pilsbry and Lowe, Proc. Acad. Nat. Sci., 1924, p. 121.
- 1935 *Cassis (Cypræcassis) coarctata* Gray, Bayer, Zoologische Mededeelingen, vol. 18, p. 96.
- 1958 *Cassis (Levenia) coarctata* Sowerby, 1825, Keen, Sea Shells of Tropical West America, Stanford, p. 340, fig. 313; 1963, Emerson and Old, Amer. Mus. Novitates, no. 2153, p. 14, fig. 11.

*Types*—From the label on Sowerby's holotype in the British Museum, it would appear that his specimen was used also by Wood in 1828

(Index Testac., pl. 4, fig. 5). Sowerby erroneously supposed his specimen might have come from New Zealand. I hereby designate Acapulco, Mexico, as the type locality.

*Records*—LOWER CALIFORNIA: (west side) Santa Margarita Island (USNM). (Gulf of California): Tiburon Id. (USNM); Santa Rosalia (ANSP; MCZ); San José Id. (USNM); Concepcion Bay; Santa Cruz Id.; Aqua Verde Bay (all USNM); Cape San Lucas (J. Xantus, MCZ; La Paz (Pilsbry and Lowe, 1932, p. 121). GULF OF CALIFORNIA (mainland side): Guaymas, Sonora (ANSP; USNM; MCZ); Mazatlan (ANSP; USNM); 10 meters, sand bottom, Ultima Isla, off Mazatlan (A. R. Cahn, coll'n., ANSP); Acapulco (B. R. Bales, ANSP). Tres Marias (USNM). NICARAGUA: Corinto (Pilsbry and Lowe, 1932, p. 121). COSTA RICA: Bahia de Salinas (USNM). PANAMA: Canal Zone (MCZ); Taboga Id., off Panama (ANSP; MCZ); Pedro Gonzales, Perlas Ids. (MCZ). ECUADOR: Punta Paitilla, Santa Elena Peninsula (T. Dranga, ANSP); Manta (USNM); Salinas (Olsson, 1924, p. 124). PERU: Mancora (Olsson, 1924, p. 124).

*Fossil records*—PLEISTOCENE: Escondido Bay, Oaxaca, Mexico (Schenck, 1926, p. 76); Punta Pulpito, Mexico (Hertlein, 1957); Coronados Id. (Durham, 1950); Cerralvo Id., Mexico (Emerson, 1960). PLIOCENE: Monserrate Id., Baja Calif (Hama and Hertlein, 1927).

### Genus *Phalium* Link, 1807

The shells in this genus are medium-sized, usually having a length of about 25 to 100 mm. (1 to 4 inches). The spire is acuminate and the last whorl well-rounded. Usually the false umbilicus (or siphonal fasciole umbilicus) and the true umbilicus are open. Many species have 1 to 7 former varices showing in the spire. The parietal shield is moderately developed, especially at the lower left region. The thick outer lip bears one row of denticles which in some species are produced into spines at the lower end. The operculum is chitinous and fan-shaped.

A number of subgenera and allied genera have been variously associated with *Phalium*. A careful study of the many morphological characters leads me to submerge such groups as *Semicassis*, *Xenophalium* and *Echinophoria* to subgeneric levels under the one genus *Phalium*. The presence of sharp spines at the base of the outer lip is peculiar to most species of *Phalium sensu stricto*, but in *Phalium bandatum* of the Indo-Pacific, a valid subspecies limited to the Indian Ocean, *exaratum* (Reeve), lacks these spines. The subgenera that we accept vary in their degree of distinctiveness. Some species bear characters common to several subgenera and therefore have in many cases been placed rather subjectively within certain subgenera. The alternative would be to continue erecting new generic names until most genera would be monotypic, a course which I believe would defeat the purpose of a classificatory system based upon phylogenetic relationships.

### Subgenus *Phalium* Link, 1807

Type: *Buccinum glaucum* Linné, 1758

The small, warm-water cassids which have a plicated or granulose columellar shield and a well-toothed outer lip are characterized by mottled tentacles and by a multi-dentate, outer marginal radular tooth. No other distinctive shell character appears to be common to all of the species which are placed here in *Phalium*. The type species, *glaucum* (Linné), has 3 or 4 spines at the base of the outer lip, a feature weakly present in two other species—*fimbria* (Gmelin) and *bandatum* (Perry). However, *P. bandatum* subspecies *exaratum* (Reeve), from the western Indian Ocean, and *P. areola* (Linné) and *strigatum* (Gmelin) do not have these spines. Similarly,

the normal number of apical varices in each species varies from none to five. The position of these former varices may produce a "humped back" appearance in three of these species, namely *glaucum*, *areola* and *strigatum*. I believe these characters are of species significance, but, because they appear from species to species in random combination, cannot be used as generic or subgeneric characters. To use these characters, and others, such as the large parietal shield in *P. fimbria*, on the generic level would result in a host of monotypic genera.

Equal difficulty arises in recognizing other closely related groups of species, and, through the years, various workers have employed such names as *Semicassis* and *Tylocassis* on either a generic or subgeneric level. I hesitantly employ *Semicassis* as a subgenus of *Phalium*. The soft

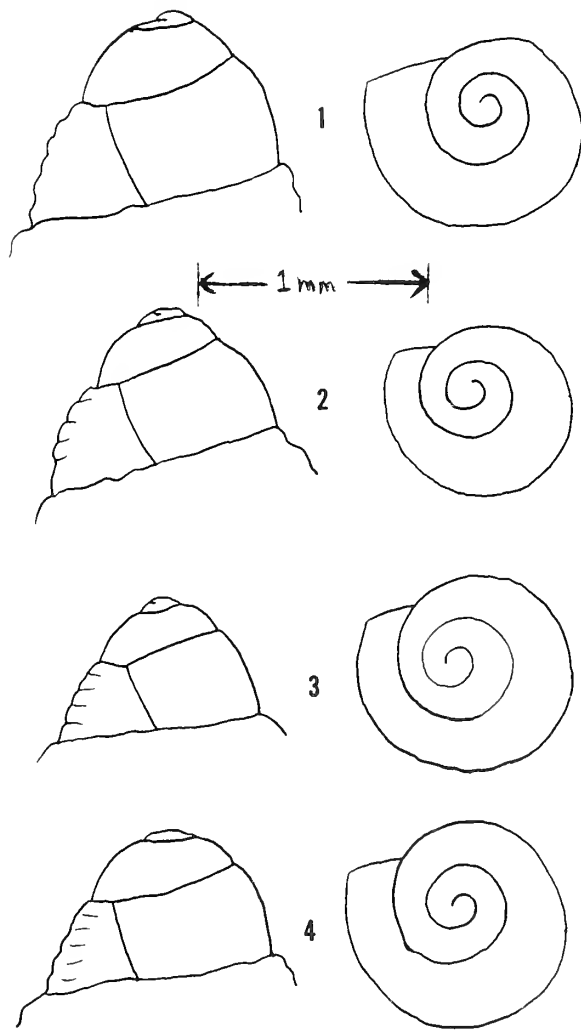


Plate 54. Nuclear whorls of *Phalium* (s.s.). Fig. 1, *glaucum* (Linné). 2, *bandatum bandatum* (Perry). 3, *areola* (Linné). 4, *fimbria* (Gmelin).

*Synonymy*—

- 1807 *Phalium* Link, Beschreibung der Naturalien-Sammlung, Rostock pt. 3, p. 112 (type by subsequent designation, Dall, 1909, Prof. Paper 59, U.S. Geol. Survey, p. 62: *C. glauca* Linné). Hermannsen's 1852, p. 104, listing is not a type designation.
- 1817 *Bezoardica* Schumacher, Essai nouv. Syst. Vers test., pp. 75 and 248. (type by subsequent designation, Cossmann, 1903, Essais Paléo. Comp., pt. 5, pp. 121, 128: *Buccinum glaucum* Lin.; and by Iredale, 1927, p. 331). Gray, 1847, Proc. Zool. Soc. London, p. 137, invalidly gave two different type designations.
- 1823 *Cassis* Children, Quarterly Jour. Sci., Literature and the Arts, London, vol. 16, p. 129 (type: *Buccinum glaucum* Linn.).
- 1840 *Cassidea* Swainson, Treatise on Malacology, London, pp. 66 and 299. (type by subsequent designation, Hermannsen, 1846, p. 192: *Cassis areola* Linn.). Non *Cassidea* Brugnière, 1789, non *Cassidea* Swainson, 1835, a dubious name. Dall's 1909, p. 61 type claim of *vibex* Linné by Swainson is untrue.
- 1961 *Bezoardicella* Habe, Coloured Illus. Shells of Japan, vol. 2, p. 43, pl. 20. (type hereby designated: *B. decussata* Linné).

parts, radulae and opercula do not appear to differ significantly. Some difficulty exists in separating the shells of *Phalium* (*Phalium*) *bandatum* subspecies *exaratum* (Reeve) and *Phalium* (*Semicassis*) *granulatum* subspecies *undulatum* (Gmelin) of the Mediterranean. The latter differs from the former only in possessing granulations or pimples on the columellar shield (instead of broken, irregular plicae). I consider the *granulatum* complex as a widespread, polytypic species existing in the Mediterranean, the Carib-

bean and the tropical Eastern Pacific, and therefore consider the one character of pimples of weak subgeneric value (*Tylocassis* Woodring, 1928).

Members of *Phalium* feed on echinoderms, live in sand, and build a tower-shaped eggmass made up of small, connected, horny egg capsules.

The group now known as *Phalium* with *glaucum* Linné as type, has been called *Bezoardica*, *Cassidea*, *Casuarina* and *Cassis* by various authors, depending upon which type species has been accepted. The excellent historical details given by Iredale (1927, Record Australian Mus., vol. 15, pp. 325-327) are summarized in our synonymy. However, I differ by considering Swainson's 1835 *Cassidea* as a *nomen dubium*. I do not consider Habe's *Bezoardicella* of sufficient significance to be recognized, even as a subgenus.

True *Phalium* probably had its origin in south Asia during the late Eocene. The Bay of Bengal is now the mid-point in the distribution of four of the species. During the Miocene most species were probably more widely distributed in the Indo-Pacific, with *Phalium areola vavakuana* (Ladd) already as far east as Fiji. Most species appear to be shrinking in range, with some of them leaving semi-isolated "pools", such as *Phalium bandatum exaratum* and the west Indian Ocean populations of *P. areola*.

**Key to the Recent Species of *Phalium* (sensu stricto)**

- a Shell with axial ribs and a full parietal shield . . . . . *fimbria*
- a Shell without axial ribs and with a small parietal shield . . . . . b
- b Base of outer lip with 3 or 4 short spines . . . . . c
- b Base of outer lip without spines . . . . . d
- c Body whorl lead gray and malleated or dented . . . . . *glaucum*
- c Body whorl with weak yellowish bands and squares; smoothish . . . . . *bandatum*
- d Body whorl strongly, spirally grooved . . . . . *bandatum exaratum*
- d Body whorl smooth or finely spirally scratched . . . . . e
- e Last whorl with 5 or 6 rows of squarish, brown patches . . . . . f
- e Last whorl with narrow, axial, wavy, brown stripes . . . . . g
- f Posterior (upper) end of outer lip with 2 prickles . . . . . *decussatum*
- f Posterior (upper) end of outer lip smooth . . . . . *areola*
- g Posterior (upper) end of outer lip with 2 prickles . . . . . *decussatum* form *flammeolatum*
- g Posterior (upper) end of outer lip smooth . . . . . *strigatum*

**Phalium glaucum (Linne, 1758)**

(Pl. 7, figs. 10-12; pls. 9, 55-57)

**Range**—East Africa to southern Japan and Melanesia.

**Remarks**—Adult *Phalium glaucum* are characterized by a rather heavy, rotund, ash-gray shell whose surface may bear weak malleations. The base of the outer lip usually has 3 or 4 strong, pointed spines. Young shells are spirally grooved. This widely distributed species is moderately common, although usually only collected singly or in pairs. It is apt to be confused in the south-west Pacific area with *Phalium bandatum* (Perry), but Perry's species has a higher spire, a more elongate shell and has more pronounced, yellowish banding on the body whorl.

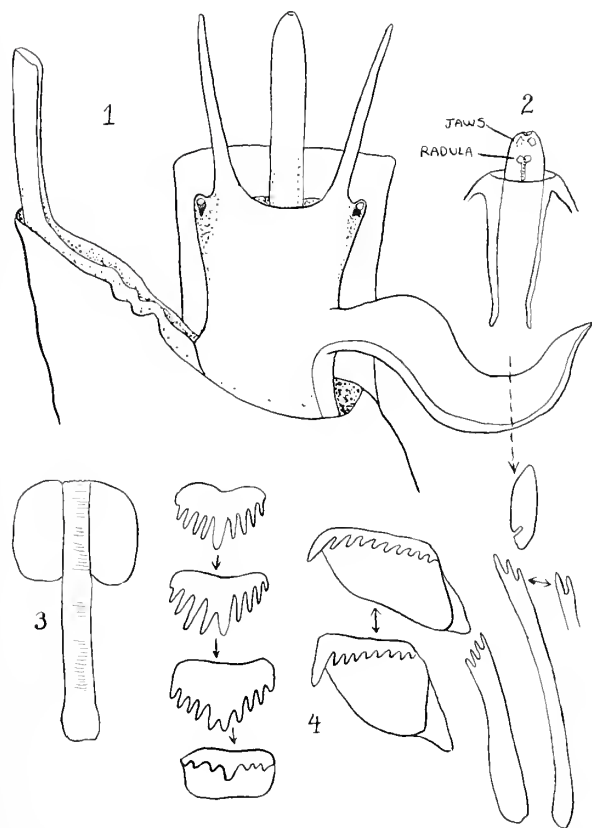


Plate 55. *Phalium glaucum* (Linné). Fig. 1, dorsal view of anterior end showing extended proboscis between the tentacles, and the penis on the right side of the head. Fig. 2, diagram of proboscis partially withdrawn. Fig. 3, radular odontophore. Fig. 4, various views of central, lateral, inner marginal and outer marginal teeth.

The description of the egg-mass given by Rumphius (1705, pp. 83-84) is similar to the egg-mass shown in our plate of *Semicassis*: "another shape of eggs of Gray Caskets [*glaucum*] I found in 1694 in October, being a clump [about the size] of a duck's egg, exteriorly dirty-yellow, rough, composed of many thin layers on top of each other. . . ; in cross-section it was more compact interiorly, of a fleshy red color mixed with spongy white substance, but there were no snails in the interior. A Casket [*glaucum*] was sitting on top and the base was attached to a stone; on the side three or four more snails were sitting" (translation courtesy of Mrs. Tera van der Feen). Rumphius stated that the boiled snail has the smell of leeks or onions. (see plate 9).

**Habitat**—Occurs in shallow water on sand near dead coral from the intertidal area to 9 fathoms. In Mozambique, it is found at all seasons, although more commonly in March, on exposed sandbanks fronting the open sea (Kurt Grosch, *in litt.*). From Rumphius' remarks (1705, p. 83) it breeds and is more commonly found in September and October in Indonesia. I have collected a number of live specimens on exposed gray sand flats on the west side of Phuket, west Thailand, in late February. They probably feed on the "sand dollars" which are abundant in the same habitat.

**Description**—Shell 63 to 120 mm. (2-1/2 to 4-3/4 inches) in length, solid, rotund, ash-gray, usually with a malleated surface, with 1 to 3 varices in the spire, and with 3 or 4 strong spines on the base of the outer lip. Nuclear whorls 2-1/2, bulimoid, smooth, translucent dark-tan. A protractively slanting growth line borders it and the spirally beaded post-nuclear whorls. Early post-nuclear whorls rounded and with 7 to 8 spiral grooves and rows of minute beads. The last 2 or 3 whorls become smoothish, except for a prominent row of small, whitish knobs on the upper shoulder and except for weak malleations on the body whorl. Suture finely impressed

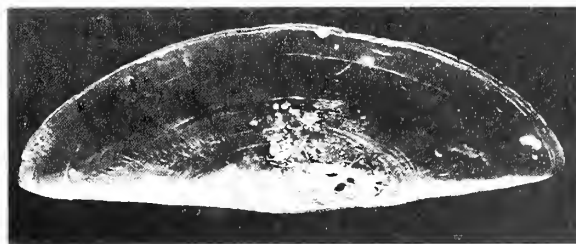


Plate 56. Operculum of *Phalium* (*Phalium*) *glaucum* (Linné). Phuket Island, west Thailand. Shell, 69 mm.; operculum, 24 mm.



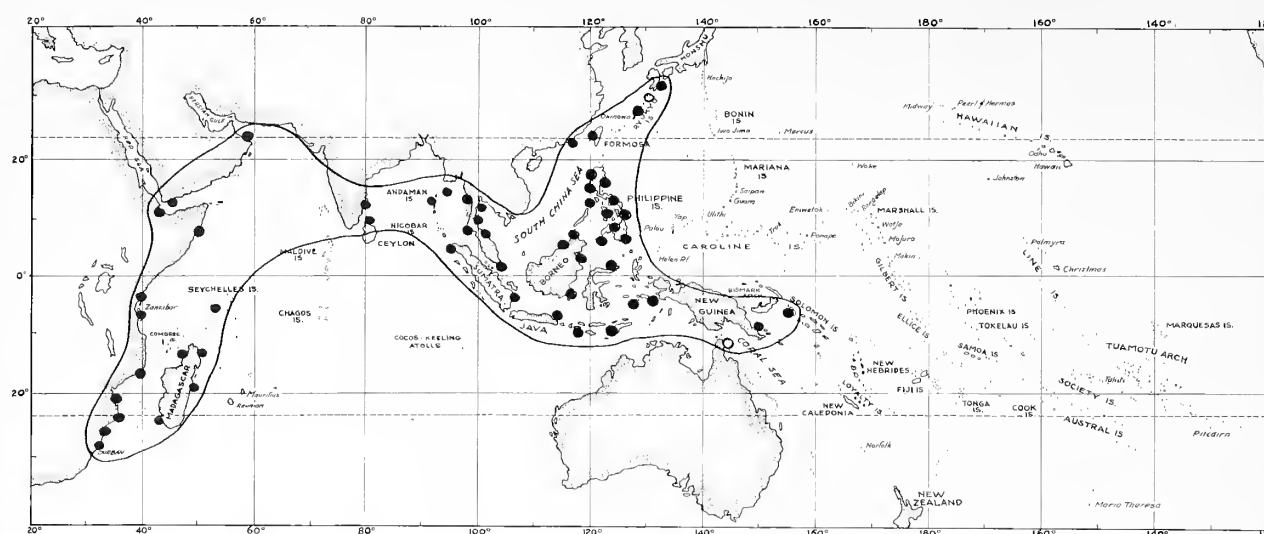


Plate 57. Geographical distribution of *Phalium* (*Phalium*) *glaucum* (Linné).

and bordered below by a weak, whitish gray, spiral swelling. Adults with 0 to 3 former varices showing in the spire. Aperture ovate, dark-brown to tan within. Outer lip strong, recurved, glossy, yellowish to light-orange with irregular banding, and bearing 6 to 20 small denticles on the inner edge. Above, the denticles may be obsolete; below they may extend into the 3 or 4 strong spikes on the base of the outer lip. Columellar shield with a raised left edge, orange-yellow, and with irregular, strong, spiral wrinklins on the columellar side. Umbilicus moderately large and very deep. False umbilicus open, slit-like and deep. Siphonal canal recurved, light-tan with a small purplish brown blotch on the dorsal surface. Operculum corneous, brownish tan, fan-shaped, with a smoothish surface, except for fine concentric growth lines and weak, radial striae and about half the length of the aperture.

*Measurements (mm.)—*

length	width	no. whorls	
120.0	77.0	7 +	large; Anping, Taiwan Id.
108.5	68.1	9	large; Inhaca Id., Mozambique
102.0	72.0	9	large; Zamboanga, Philippines
90.0	58.2	8 +	average; Okinawa Island
61.7	40.5	6 +	small; Kudat, North Borneo

*Synonymy—*

1758 *Buccinum glaucum* Linné, *Systema naturae*, ed. 10, p. 737 (O. Asiatico); refers to Rumphius, pl. 25, fig. A; Gualtieri, pl. 40, fig. A; 1764, Mus. Lud. Ulrich, p. 606, no. 256; 1767, ed. 12, p. 1200, no. 453; 1795, Spalowsky, *Prodrome Syst. Hist. Testac.*, Wien, p. 37, pl. 6, fig. 1; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 111, p. 188.

[1786 *Buccinum galca-ferrea* Martyn, *Universal Conch.*, pt. 3, 1786, pl. 91, right figure. Rejected work].

[1797 *Cassida bezoar* Humphrey, *Museum Calonnianum*, p. 19. New name for *Buccinum glaucum* Linné, 1758. Non-binomial work].

1807 *Phalium glaucum* Linné, Link, *Beschr. Natural-Samml.*, Rostok, pt. 2, p. 112; 1869, Frauenfeld, *Verhand. Kaiser-könig. Zool.-Botan. Gesell. Wien*, vol. 19, abh. p. 862 (Nicobar Islands).

1817 *Bezoardica vulgaris* Schumacher, *Essai Nouveau Syst. Test.*, p. 248. New name for *Buccinum glaucum* Linné.

1822 *Cassid. glauca* Linné, Lamarck, *Anim. sans Vert.*, vol. 7, p. 221, no. 6; 1832, Quoy and Gaimard, *Voyage Astrolabe, Zoologie*, vol. 2, pp. 593-596, pl. 43, figs. 9-13.

1839 *Cassid. bezoar* Gray, *Zoology of Beechey's Voyage*, London, p. 121 (operculum only).

1911 *Cassideu strigata* L., Shirley, *Proc. Royal Soc. Queensland*, vol. 23, p. 98 (juvenile). [fide Iredale, 1927, p. 331; wrong reference?].

1927 *Phalium (Phalium) glaucum* (Linné), Iredale, *Records Australian Museum*, vol. 15, p. 331; 1935, Bayer, *Zoologische Mededeelingen*, vol. 18, p. 99.

*Types*—According to Dodge (1956, p. 188) a specimen conforming to *glaucum* of authors (and also our concept) is in the Linnaean collection in London and may serve as the type. The type locality is "In O. Asiatico", and we further restrict it to Ambon Id., Indonesia.

*Records*—(see accompanying map)—SOUTH AFRICA: St. Lucia Inlet, Zululand (V. Orr, ANSP). MOZAMBIQUE: Inhaca Id., Delagoa Bay (William Macnae, ANSP); Mozambique City (Kurt Grosch, ANSP); Vilanculos, Bazaruto Bay (J. K. Howard, MCZ); Port Amelia (MCZ). ZANZIBAR: (R. T. Abbott, USNM). KENYA: Lamu Id. (A. Loveridge, MCZ). FRENCH SOMALIA: Dorale, near Djibouti (N. Lavergne, ANSP). SOMALIA: Chisimaio (O. Davis, ANSP). ADEN: Kagimakser (H. Strengers, Rijksmus. Nat. Hist. Leiden). SAUDI ARABIA: Muscat, Gulf of Oman (Don Bosch, ANSP, AMNH). MADAGASCAR: Ankify A. Chavane, ANSP; Ambatoloaka, Nossi-bé (Acad. Exped., 1960, ANSP); Ilanivato, Ile Ste. Marie (R. W. Foster, MCZ). SEYCHELLES: North West Bay, Mahé, (Winckworth, Brit. Mus.). INDIA: Madras

(Brit. Mus.). ANDAMANS: Port Blair (Manchester Mus., Harnett coll'n). CEYLON: Gulf of Manaar (George and Mary Kline, ANSP). BURMA: North Prepara Channel, 52 meters, *Anton Bruun* Sta. 43, Apr. 1, 1963 (ANSP); Maungmagen, near Tavoy (C. T. Brues, MCZ). THAILAND: (west side) Phuket Id. (Andrew Peters, ANSP); (Gulf of Siam side): Prochuab (G. M. Moore, MCZ); Koh Samet; Koh Chang (both H. M. Smith, USNM). MALAYA: Singapore (S. Archer, ANSP). INDONESIA: Biliton Id., Sumatra; Boesak and Menado, Celebes; Ambon; Timor; Madura, Java; Gulf of Corontalo; Ampanan, Lombok (all Rijksmus. Leiden); Ceram Id. (L. J. Butot, ANSP); Banda Id. (Paleo. Res. Inst. Ithaca); Lho Seumaweh, Atjeh, Sumatra; Sangir; Soengeiliat (all Zool. Mus. Amsterdam). BORNEO: Maruda Bay; Aru, Jesselton (both Mary Saul, ANSP). JAPAN: Tosa (MCZ; ANSP); Miyazaki Pref., Kyushu Id. RYUKYU IDS.: Okinawa (A. R. Cain, coll'n, ANSP); Miyako Id. (Anita Scott, coll'n). CHINA: Swatow (Moellendorff, Berlin Mus. TAIWAN: Anping (ANSP); Takao; Hoko (Kuroda, 1941, p. 104). PHILIPPINES: Luzon Id., Iba, Zambales (P. de Mesa, ANSP); Cabalao Id., Polillo Ids.; Subic Bay, Zambales (both P. de Mesa, MCZ); Lusong Cove, Bataan (duPont-Academy Exped., 1958, ANSP); Olongapo; Port San Vicente (both USNM). Mindoro Id.: Pinnamalanay (USNM); Paluan Bay (USNM); San Teodoro (MCZ); Naujan (P. de Mesa, MCZ). Cuyo Id.; Jolo Id.; Zamboanga, Mindanao (all ANSP). NEW GUINEA: Fak Fak (Rijksmus. Leiden). Wasior; Merauke (both Zool. Mus. Amsterdam); Oro Bay (ANSP). SOLOMONS: Buin, Bougainville Id., (Fred Parker, ANSP).

*Fossil Records*—PLIOCENE: Karikal, India (Cossmann, 1903, Jour. de Conchyl., vol. 51, p. 160, pl. 6, fig. 9, as *Semicassis strigata* Gmelin); Poetjangan layers, Rembang, Java (Altena, 1942, p. 93); Billiton, Java (K. Martin, 1881, p. 20).



Plate 58. *Phalium bandatum bandatum* (Perry). Holotype of *Cassis coronulata* Sowerby. British Museum (Natural History). 91.2 mm. in length.

### *Phalium bandatum subspecies bandatum* (Perry, 1811)

(Pl. 7, figs. 14, 15; pl. 58)

*Range*—Western Pacific from southern Japan and the Philippines, south through Indonesia to the northern half of Australia.

*Remarks*—This handsome, moderately common species bears a very close resemblance to *Phalium glaucum* (Linné), but it differs in being proportionately more elongate, in having spiral bands of large, squarish, light yellow-brown blotches on the body whorl and axial flames on the spire, and in usually having more tabulate whorls in its drawn-out spire. *Phalium glaucum* generally has dark, bluish gray covering the weak spiral bands of yellowish, and may have a strongly malleated surface. I can find no significant differences in the varices, dentition on the outer lip, the spines at the base, or the wrinkles on the columellar shield.

The distribution of *bandatum bandatum* is confined to a relatively narrow, north-south area running from central Japan to both sides of Australia. *Phalium glaucum* has a much wider, east-west distribution which extends from East Africa to Melanesia. *P. bandatum* evidently can withstand cooler waters. I can find no significant differences in the Japanese, East Indian and Australian populations.

*Habitat*—Mrs. Joy Kerslake informs me that in Queensland this species is sometimes captured in deep-water prawn nets in great quantities. Bernice Albert has obtained it alive in 4 feet of water in Okinawa, and the "Albatross" dredged it in fresh condition in 18 fathoms in the Philippines. In Western Australia it has been collected at depths from 14 to 40 fathoms on sand bottom.

*Description*—Shell 55 to 115 mm. (2¼ to 4½ inches) in length, solid, slightly elongate, cream-white with diffused banding and squarish spotting of yellow-brown, usually with a smooth surface, and with 2 or 3 poorly developed spines at the base of the outer lip. Nuclear whorls 2, glossy, opaque-white. Post-nuclear whorls rounded, slightly shouldered, and with 6 to 8 beaded cords which disappear in the last two whorls. Last two whorls shouldered by a spiral row of small whitish knobs. Whorls bear 1, 2 or no former varices. Color of outer shell white or cream and with 5 spiral, light-yellowish bands on which are darker squares of yellow-brown. Axial flames of brownish are fairly prominent below the suture and may extend on to the body whorl. Exterior of

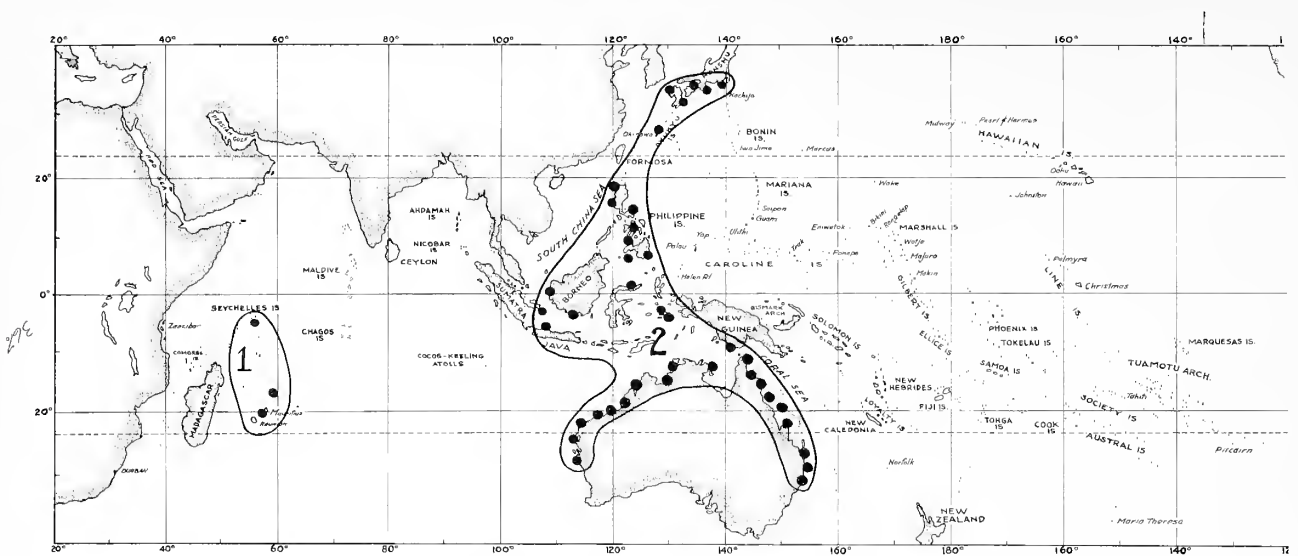


Plate 59. Geographical distribution of *Phalium* (*Phalium*) *bandatum* (Perry). 1, subspecies *exaratum* (Sowerby); 2, typical subspecies *bandatum* (Perry).

siphonal canal and the gutter to its right are usually stained with light purplish brown. Interior of aperture whitish to dark brownish. Columella shield and glossy outer lip whitish, yellowish or brownish orange. Other features, including dentition of the outer lip, similar to those in *Phalium glaucum*.

#### Measurements (mm.)—

length	width	no. whorls	
124.0	73.0	9	large; Jolo Id., Philippines.
115.0	69.0	7+	large; Cebu City, Philippines
95.0	59.0	6+	average; Cebu City, Philippines
91.2	54.0	7+	Type of <i>coronulata</i> Sby.
85.7	49.0	9	Sagami Bay, Japan
84.5	46.9	9	Queensland, Australia
55.6	35.7	8	small, Queensland, Australia

#### Synonymy—

- 1811 *Cassidea bandata* Perry, Conchology, London, pl. 34, fig. 2 (East Indies).  
 1825 *Cassis coronulata* Sowerby, Catalogue Shells, Earl Tankerville, London, p. 70, no. 1823 and appendix, p. xx, no. 1823 (no locality); 1848, Reeve, Conch. Icon., vol. 5, Cassis, pl. 12, fig. 31 (Philippine Islands).  
 ?1828 *Cassis muricata* Menke, Synopsis Methodica Molluscorum, Pymont, p. 36 and 86 (ad Javam); 1830, ed. 2, p. 144 [Young and nomen oblitum].  
 1835 *Cassis glauca* Brug., var. Kiener, Coquilles Vivantes, Paris, vol. 8, Cassis, p. 27, 29, pl. 1, figs. 1 (living animal in color).  
 1873 *Semicassis* (*Phalium*) *coronulata* Sowerby, Brazier, Proc. Zool. Soc. (London) for 1872, p. 838 (New South Wales).  
 1910 *Cassidea coronulata* Sowerby, Hedley, Report Australian Assoc. Adv. Science, Brisbane, for 1909, p. 361 (Queensland).

1918 *Phalium coronulatum* Sowerby, Hedley, Jour. and Proc. Royal Soc. New South Wales, (1917), vol. 51, p. 67.

1927 *Phalium bandatum* (Perry), Iredale, Records Australian Museum, Sydney, vol. 15, p. 332; 1935, Ch. Bayer, Zoologische Mededeelingen, vol. 18, p. 99.

**Nomenclature**—Iredale in 1927 associated the name *Cassidea bandata* Perry, 1811, with Sowerby's better-known *Cassis coronulata* Sowerby, 1825, I think on rather slim grounds, for Perry's poor figure and the descriptive words "shell white and gray—mouth a lively brown" fit some specimens of *glaucum* Linné which have bands of color on the parietal wall. In view of Perry's remarks concerning the "red" spots on the outer lip, and because Kuroda, Ch. Bayer and others acceded to this view, I am also employing the name *bandatum*.

Among the early woodcut drawings of this species are those of Seba, 1758, pl. 71, figs. 14 and 15, but I know of no valid names that have been applied to them.

**Types**—I was unable to find Perry's type of *Cassidea bandata* in any of the major museums in England in 1962. The type locality is "East Indies". I further restrict it to Olango Island, just east of Cebu City, Cebu Island, Philippines. Sowerby's type of *coronulata* from the Tankerville collection is in the type collection of the Mollusca Section of the British Museum (of Natural History) in London (1962). Sowerby gave no locality.

**Records**—JAPAN: Kagoshima; Nagasaki; Hirado, Hizen; Oshima (all USNM); Kii, Honshu, 10 fms.; Miyazaki Pref., Kyushu Id.; Nagasaki (all MCZ); Tosa; Sagami Bay; Wakayama (all ANSP). RUYKYU ID.: 4 ft., Chinen sand flat, Okinawa Id. (Bernice Albert, ANSP). PHILIPPINES: San Miguel



Id., Albay Prov., Luzon Id. (duPont-Academy Exped., 1958, ANSP); Alabat Id., Luzon Id.; Mariveles, Bataan, Luzon Id. (both Sally Kaicher, coll'n.); Subic Bay and Atimonan, Luzon Id. (both USNM); Olango Id., Cebu Id. (E. Zambo, ANSP); Zamboanga, Mindanao Id. (ANSP); Davao Bay, Mindanao Id.; Jolo Id., Sulu Sea; 18 fms. off Tataan Id., "Albatross" station 5156 (all USNM). INDONESIA: Biliton Id., Sumatra; Amboina; Menado, Celebes Id., (all Rijksmus. Nat. Hist. Leiden); Ceram Id. (L. J. Butot, ANSP). BORNEO: Mampawa (Berlin Mus.). NEW GUINEA: Merauke (south coast) (Zool. Mus. Amsterdam). AUSTRALIA: Western Australia: 40 fms., off Dirk Hartogs Id., Shark Bay; 23 fms., off Delambre Id., Dampier Archip.; 20 fms., off Roebourne, 23 fms., off Legendre Id.; 14 fms., off Sholl Id., (all Weaver and King, 1960, BPBM); La Grange Bay (A. R. Whitworth, ANSP); Mount Yokina (V. Orr, ANSP); Geraldton (West Aust. Mus.); Abrolhos Ids. (A. Kalmus, coll'n.); Northern Territory: Port Samson; off Darwin (both A. R. Cahn coll'n., ANSP); 15 fms., off Cape Ford (Vernon Wells, ANSP); Yirrkala, Arnhem Land; Groote Eylandt, Gulf of Carpentaria (both R. R. Miller, USNM). QUEENSLAND: Bedford Beach (Mrs. J. A. Grigg, USNM); Brampton Beach, Bowen (USNM); sand flats, Port Douglas (Tony Marsh, ANSP); Noosa Beach (ANSP); Magnetie Id., near Townsville; Darnley Id., Torres Straits; Bedford Beach, Cooktown; Burleigh Heads (all MCZ); Yeppoon Beach, near Rockhampton (Mrs. A. R. Bowman, ANSP); off Caloundra (Joy Kerslake, ANSP). NEW SOUTH WALES: off Newcastle (T. Hartley, ANSP); Woolgoolga (Joy Kerslake, ANSP); 30 fms., off Evans Head (T. A. Garrard, ANSP).

*Fossil records*—None reported.

***Phalium bandatum subspecies***

***exaratum* (Reeve, 1848)**

(Pl. 7, fig. 17; pl. 60)

*Range*—Central Indian Ocean from the Seychelles to Réunion to the Cargados Islands. (Possibly Mauritius and the Chagos).

*Remarks*—This curious, somewhat geographically isolated subspecies is evidently the Indian Ocean replacement for *Phalium bandatum bandatum* (Perry) of the Western Pacific. Deshayes (1863, p. 114) was the first to ascribe a definite locality, and subsequent authors have outlined its present known range. *P. exaratum* is distinguished from *bandatum* by the spiral grooves on the body whorl of adults, by the very granular or beaded upper whorls, by the less pronounced shouldering of the whorls, and by the absence or reduction of the three spines at the base of the outer lip. The name *exaratum* is the Latin for plowed up or furrowed, evidently in allusion to the spiral, incised lines on the body whorl. Very young *bandatum* have these spiral cords.

Curiously, the shell is very similar to *undulatum* (Gmelin, 1791) of the Mediterranean, particularly with regard to spiral sculpturing, varical features and coloring. However, *undulatum* has the significant, granular pimples on the columellar shield and a proportionately higher spire. The resemblance in the spiral grooving is evidently superficial.

*Habitat*—Not known, although presumably on sand bottom in several feet of water.

*Description*—Shell 75 to 100 mm. (3 to 4 inches) in length, solid, rotund, spirally sculptured, with a coarsely granulated spire and with indistinct, irregular, yellowish brown blotches on the last whorl. Nuclear whorls not observed. Whorls about 7. Early postnuclear whorls coarsely beaded, later whorls with 4 to 6 spiral cords, usually beaded, on the shoulder. Body whorl with about 15 evenly-spaced, spiral incised lines between which are large, almost flat spiral cords. A former varix may be present  $\frac{1}{3}$  turn



Plate 60. *Phalium bandatum* subspecies *exaratum* (Reeve). Leotype. British Museum (Natural History). 82.3 mm. in length.



posterior to the last varix. Aperture elongate; the outer lip with 19 to 23 cream teeth of which the middle 4 or 5 are the largest. Parietal shield well-developed, its left edge smooth and raised. Columellar area with numerous, fine, raised, sometimes interrupted spiral cords. Base of outer lip without prominent projections. Color of shell cream and with 5 spiral rows of irregularly-squarish, indistinct, yellow-brown blotches. Operculum and soft parts unknown.

*Measurements (mm.)—*

length	width	no. whorls	
109.0	66.1	7 +	large (Amer. Mus. Nat. Hist.)
100.0	64.5	7 +	Seychelles Islands
92.0	52.0	6 +	Mahé Id. (Brit. Mus.)
82.3	47.3	6 +	lectotype (Brit. Mus.)
75.0	49.0	6 +	Cargados Archipelago

*Types*—The type of *exaratum* is in the British Museum of Natural History, London, where I examined it.

*Synonymy*—

1848 *Cassis exarata* Reeve, *Conchologica Iconica*, vol. 5, *Cassis*, pl. 12, fig. and sp. 32 (locality unknown); 1863, Deshayes, *Cat. des Moll. l'île de la Réunion*, Paris, in L. Maillard, p. 114, no. 380 (Réunion); 1901, R. Delano, *Cat. Doane Coll. Shells*, Marion Nat. Hist. Soc., Wareham Press, Mass., p. 35 (Réunion).

*Records*—SEYCHELLES: (ANSP and AMNH); North West Bay, Mahé, (Winckworth, BM). RÉUNION ID.: (Deshayes, 1863, p. 114). MAURITIUS: (Dautzenberg coll'n., Bruxelles). CARGADOS IDS.: Eda Couacaud, 1967, ANSP; (Mauritius Inst.; Liénard, 1877, p. 107). [Castro de Elera's 1896, vol. 3, p. 226, Manila, Philippines, record is probably based upon a young *bandatum*. Salmon's 1948 records are based on young *glaucum* L.]

*Fossil records*—None reported.

***Phalium areola* (Linne, 1758)**

(Pl. 7, figs. 5-7; pls. 61, 63)

*Range*—East Africa to Melanesia and Samoa.

*Remarks*—This well-known and rather widely-distributed species is characterized by the five, spiral rows of large squarish spots of chestnut-brown or yellowish tan on the last whorl. The smooth dorsum is sometimes slightly humped because of an underlying, former varix. Immature specimens have a weak cancellate sculpturing formed by fine axial growth lines and numerous spiral grooves. Adults, including some from northwestern Australia, have a smooth last whorl. Iredale's *agnitum* is an immature form of *areola* (pl. 7, fig. 13). The species appears to be largely limited to large volcanic islands or continental shores. The spotting on the last whorl is variable in color density and in the shape of the spots. I can find no difference between western Indian Ocean and southwest Pacific shells.

I have not seen a sufficient series of *decussatum* (Linné) with good locality data to determine its relationship with *areola*. The former differs in having its shell flattened dorso-ventrally and in having two whitish prongs on the upper end of each varix. To my knowledge, *decussatum* occurs only in Indonesia and Taiwan, although it is likely to be found in the Philippines and perhaps the southeast mainland of China. Provisionally, we are considering the two as separate species.

*Habitat*—An intertidal, sandy mud-dwelling species, sometimes dredged from depths of two to four fathoms.

*Description*—Shell 39 to 91 mm. (1-1/2 to 3-3/4 inches) in length (usually 2-1/2 inches), solid, heavy, with 5 rows of large, squarish brownish spots, with 2 to 5 former varices showing in the spire, and with a moderately developed columellar shield. Nuclear whorls 2, bulimoid, smooth, glossy, white or tan. Post-nuclear whorls slightly round, and bearing about 5 to 7 spiral rows of fine beads which disappear in the last whorl. 2 to 5 former varices present in the spire. Last whorl smoothish, but may have weak axial wrinkles on the shoulder and 3 or 4 weak spiral grooves at the base. The dorsum is sometimes humped because of an underlying, former varix. Aperture elongate, tan to dark-brown within. Parietal shield moderately developed, 3 rows of square spots showing on the parietal wall; the left edge of the columellar shield is sharp and is cemented to the lower half of the first former varix. Col-

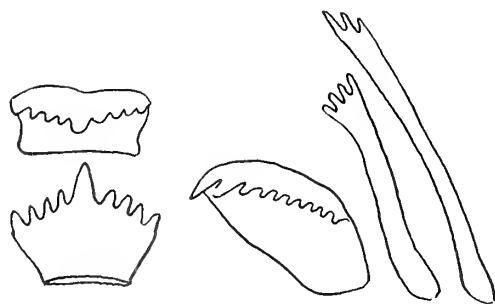


Plate 61. *Phalium areola* (Linné). Radula of female from Phuket, Thailand.

umella with a dozen or so slanting, irregular, raised, whitish plicae and elongate pustules. The upper end of the parietal wall bears 2 to 4 short, oblique plicae. Outer lip thick, whitish, with 5 weak, mauve bars, and with about 15 to 20 small, raised teeth on the inner edge. Siphonal canal short, recurved and stained with mauve-brown on its inner edge. Umbilicus almost sealed by a former varix. False umbilicus sealed or minutely open.

#### Measurements (mm.)—

length	width	no. whorls	no. varices	
91.0	54.0	8	5	large; locality unknown
83 +	50.0	6 +	6	large; Ryukyu Ids.
69.0	40.7	8	6	Queensland, Australia
63.3	39.0	9	3	average; Luzon, Phil. Ids.
60.0	39.0	8	5	Nossi-bé, Madagascar
57.5	35.0	7	3	holotype of <i>agnitum</i>
39.0	26.1	7 +	4	small; New Britain Id.

#### Synonymy—

- 1758 *Buccinum areola* Linné, Systema naturae, ed. 10, p. 736, no. 389 (M. Mediterraneo [erroneous]); refers to Buonanni, fig. 154; Rumphius, pl. 25, fig. 1, B. 2; Gualtieri, pl. 39, figs. H, G; and Argenville, pl. 18, fig. 1; 1767, Syst. nat., ed. 12, p. 1199, no. 451; 1956, Dodge, Bull. Amer. Mus. Nat. Hist., vol. 111, art. 3, pp. 183-185.
- 1792 *Cassidea areola* Bruguière, Encyclopédie Méthod., Vers., vol. 1, p. 423, no. 8; 1840, Swainson, Treatise Malacol., London, p. 299.
- 1798 *Cassis alea* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 31; refers to Conchyl.-Cab., vol. 2, figs. 355, 356 and Knorr, pt. 3, pl. 8, fig. 5.
- 1807 *Phalium areola* Link, Beschreibung Naturalien-Samml., Rostok, pt. 2, p. 112, refers to Conchyl.-Cab., vol. 2, fig. 355 (no locality).
- 1807 *Phalium clathratum* Link, loc. cit., p. 113 (no locality).
- 1807 *Phalium extinctum* Link, loc. cit., p. 112 (no locality).
- 1807 *Phalium sulcatum* Link, loc. cit., p. 113 (no locality).
- ? 1808 *Phalium alea* Link, loc. cit., pt. 6, p. 33 (no locality). [*alea* in Sherborn, 1932, p. 820].
- 1816 *Cassis areola* Lamarck, Le Liste, Encyclop. Méth., Vers., pl. 407, p. 3; 1822, Anim. sans Vert., vol. 7, p. 222, no. 9.
- 1817 *Bezoardica areolata* Schumacher, Essai Nouveau System. Test., p. 248 (new name for *areola* Linné, 1758). (no locality).
- 1873 *Semicassis (Phalium) areola* L., Brazier, Proc. Zool. Soc. London, 1872, p. 837 (New South Wales).
- 1877 *Cassis aureola* Brug., Liénard, Cat. Faune Malacologique Maurice, Paris, p. 75 (Seychelles). Error for *aerola* Linné, 1758.
- 1885 *Cassis (Bezoardica) areola* Linn., Tryon, Manual of Conchology, vol. 7, p. 276, pl. 6, fig. 84.
- 1925 *Cassis (Phalium) areola* (Linné), Oostingh, Mededeel. Landbouwh. Wageningen Nederl., vol. 29, pt. 1, p. 116.
- 1927 *Phalium agnitum* Iredale, Records Australian Mus., Sydney, vol. 15, p. 332, pl. 32, fig. 10 (Western Australia).
- 1935 *Phalium (Phalium) areola* (Linné), and form *küsteri* Bayer, Zoologische Mededeelingen, Leiden, vol. 18, p. 98.

1936 *Phalium exaratum* Reeve, subspecies *agnitum* (Iredale), Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 99.

1961 *Bezoardicella areola* Linné, Habe, Coloured Illust. Shells of Japan, pt. 2, p. 43, pl. 20, fig. 8.

*Types*—According to Dodge (1956, p. 184) “a specimen of the *areola* of authors is present in the Linnaean collection in London”. The original type locality was “In M. Mediterraneo”, but this is evidently erroneous. In 1767, Linné added “Java” to the locality records. Dodge has a lengthy discussion about the early identity of this species. He was unaware of the five later synonyms which we listed above. Iredale’s holotype of *agnitum* from “Western Australia” is in the Australian Museum in Sydney, no. C. 53269.



Plate 62. *Phalium areola* (Linné). Holotype of *Phalium agnitum* Iredale, 1927. Western Australia. Australian Museum no. C 53269.

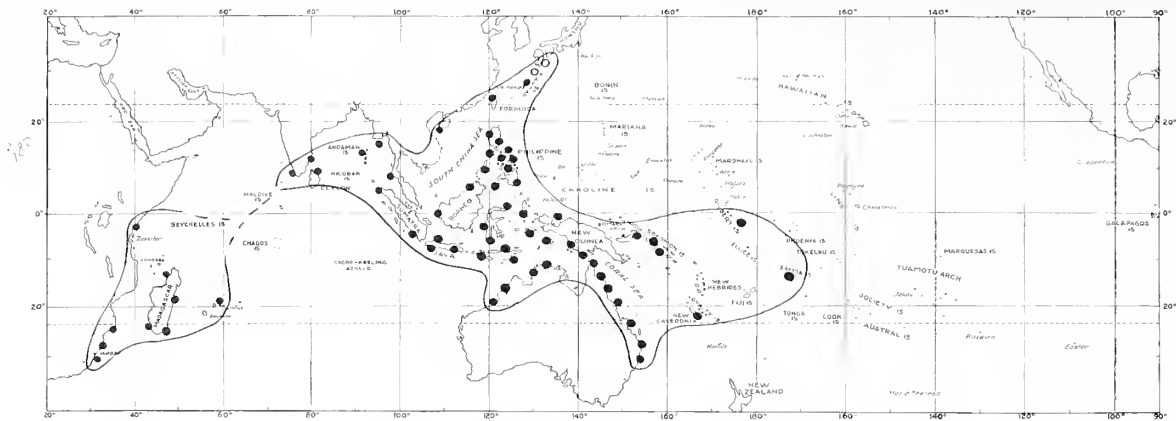


Plate 63. Geographical distribution of *Phalium* (*Phalium*) *areola* (Linné). The species is absent or very rare in the central islands of the Indian Ocean.

*Records* (see accompanying map)—SOUTH AFRICA: St. Lucia Inlet, Zululand; Umhlali, 30 mi. north of Durban (both V. Orr, ANSP); Isazela, Natal (H. C. Burnup, USNM); Durban (Brit. Mus.). MOZAMBIQUE: Inhaca; Bazaruto Bay (both J. K. Howard, MCZ). KENYA: Lamu Id. (MCZ). MADAGASCAR: Fort Dauphin; Androka, near Tuléar; Tamatave (all C. Petit, Mus. Roy. Hist. Nat. Belgique); Andilana, Nossi-bé (A. Chavane, ANSP). MAURITIUS: (Mauritius Inst.). INDIA: Cochin (Certrude Irvine, ANSP); Madras (Nat. Mus. Wales; BM). CEYLON: Mullaitivu (Jonklaas, ANSP); Trincomalie (MCZ). ANDAMANS: Port Blair (H. M. Parish, BM). BURMA: 53 meters, Prepara North Channel, *Anton Bruun* Sta. 43, Apr. 1, 1963 (ANSP). THAILAND: Phuket Id., Bay of Bengal (Andrew Peters, ANSP). CHINA: Sang-ja, Hainan Id. (A. D. Scarlato, Zool. Inst. Leningrad). JAPAN: Miyazaki Pref., Kyushu Id. (Kuroda, 1934, p. 50). RYUKYUS: Miyako Id. (Anita Scott, coll'n.). TAIWAN: Karenko (Kuroda, 1941, p. 104). PHILIPPINES: uncommon throughout Luzon, Mindoro, Palawan, Panay, Samar, Marinduque, and Mindanao Ids. (USNM, ANSP and MCZ). INDONESIA: Wijnkoopsbaai, Java; Banda Id. (both Natuurhist. Mus. Enschede); Menado, Celebes Id. (A. Pasuhuk, ANSP); Bantam, Java (USNM); Benkoelen, Sumatra Id. (USNM); Obi Major, Moluccas; Boelien Weda Bay, Halmahera Id.; Ceram Id.; Ternate Id.; Timor Id.; Misool Id. (all Rijksmus. Nat. Hist. Leiden); Tjalong, Atjeh, Sumatra Id.; Makassar, Celebes Id.; Ende, Flores Id. (all Zool. Mus. Amsterdam); Tjilaet Eureum, Java Id. (Mus. Roy. Hist. Nat. Belg.). NEW GUINEA: Soembawa; Kaimana (both Mus. Roy. Hist. Nat. Belg.); Djamma Ids. (MCZ); Passang Kajoe, west Celebes Id. (Paleo. Res. Inst. Ithaca); Merauke (USNM); 4 fms., Koeroedoir Id., Ceelvinck Bay (A. J. Ostheimer, 3rd, ANSP). BISMARCKS: Rabaul, New Britain Id. (E. H. Schlosser, ANSP). AUSTRALIA: Western Australia: Sam's Creek, Port Samson (B. R. Wilson, West. Aust. Mus.); Augustus Id. (MCZ); Northern Territory: Darwin (MCZ). Queensland: Darnley Id., Torres Straits; Flattery Bay, Cooktown; Caloundra; Moreton Bay (all MCZ); Cladstone; Bowen (both USNM); Yeppoon; Tin Can Bay (Joy Kerslake, ANSP); Green Island, near Mackay (T. A. Carrard, ANSP); Brampton Beach (T. Hartley, ANSP); Port Douglas (MCZ and Tony Marsh, ANSP). New South Wales: off Trial Bay (Joy Kerslake coll'n); Broken Bay, near Sydney (Aust. Mus.); Newcastle (USNM). SOLOMONS: Guadalcanal Id. (ANSP); Kunua, Bougainville (Fred Parker, 1963, ANSP); Buin, Bougainville (Mus. Roy. Hist. Nat. Belg.). NEW CALEDONIA: Poindimié (Joy Kerslake, coll'n.). CILBERT IDS.: Butaritan (J. S. Edmondson, BPBM). SAMOA: Samatau, Upolu Id. (A. J. Ostheimer, rd., 1955, ANSP).

*Fossil records*—PLIOCENE: Byoritu Beds of Wangwa, Taiwan (Nomura, 1935, p. 168, pl. 8, fig. 24 (not 38)). Other literature records, unaccompanied by illustrations, may be misidentifications.

***Phalium areola***  
***subspecies vavakuana* (Ladd, 1934)**

*Range*—Miocene of Fiji.

*Remarks*—This subspecies is almost indistinguishable from young specimens of *Phalium areola areola* which also have only 2 or 3 varices in the spire and have a cancellate sculpturing on the upper portions of the whorl and spiral bands on the lower portion.

*Description*—(from Ladd). Shell medium-sized, moderately inflated, spire low, shoulder strong; aperture elongate, narrowed posteriorly, wide anteriorly and reflected as a short, deep canal; siphonal fasciole much inflated. Inner lip thick and heavily callused, its margin detached from the body whorl below; inner margin of inner lip bearing a series of ridges which are long and irregular near the base, inconspicuous immediately above the base, and again prominent posteriorly. Outer lip greatly thickened, reflected, marked by long lirae within. Sculpture of body whorl below shoulder consisting of uniformly narrow, flattened, spiral bands crossed by a few fine axial striae; shoulder nodose or bordered by an elevated rim; above the shoulder on the body whorl the spiral bands are irregularly spaced and are beaded by axial striae; spire cancellated; suture carinated; 2 or 3 smooth, rounded varices present. The holotype retains some of its original color, the body whorl being brown, the lips yellowish.

Holotype (B.P. Bishop Mus., Geol. no. 1206): length 35.0 mm., diameter 22.9 mm. A paratype (B.P. Bishop Mus., Geol. no. 1207) is incomplete but compares favorably in size with the holotype.



*Type locality*—Station 59, right bank of Wailoa River about 1 mi. west of Nasongo; elevation 995 feet; Viti Levu, Fiji; Suva formation; Miocene.

*Synonymy*—

1934 *Semicassis* (*Semicassis*) *vavakuana* Ladd, Bull. 119, B.P. Bishop Museum, p. 222, pl. 39, fig. 12.

*Records*—Known only from the type locality.

***Phalium areola***

*subspecies glaucoides* (K. Martin, 1879)

*Range*—Upper Miocene of Java.

*Remarks*—I have examined the holotype of *glaucoides* which is 25.3 mm. in length, and found it difficult to separate from Recent specimens of inch-long *Phalium areola*. K. Martin's original figure 8 does not show the axially pinched riblets on the shoulder. He likened his *glaucoides* to the Recent *glaucum* (Linné), but the latter rarely, if ever, has a former varix in the spire, lacks the axial beaded riblets on the shoulder and has more widely-spaced, spiral, incised striae on the lower half of the body whorl. The Miocene *glaucoides* appears to differ from the Recent *areola* in having a lower spire and in having stronger beading on the axial riblets on the shoulders.

*Synonymy*—

1879 *Cassis glaucoides* K. Martin, Die Tertiärschichten auf Java, Leiden, p. 45, pl. 8, fig. 8 (Tji Kantang and Tji Lautoron, Java; Upper Miocene). Type in the Rijksmus. Geol. Mineralog. Leiden.

***Phalium menkrawitense* Beets, 1941**

(Pl. 64)

*Range*—Upper Miocene of east Borneo.

*Remarks*—This species appears to be related to the Recent *areola* Linné. Although the body whorl is smooth, there appear to be numerous axial wrinkles just below the suture. The holotype is probably an immature specimen. The paratype, although broken, shows a broad parietal shield.

*Synonymy*—

1941 *Phalium* (*Phalium*) *menkrawitense* Beets, Verhandelungen Geologisch Mijnbouw Genoots, Nederland en Kolon, Geol. Series, vol. 13, p. 85, pl. 4, figs. 180-186 (Upper Miocene; Mangkal, east Borneo).

***Phalium strigatum* (Gmelin, 1791)**

(Pl. 7, figs. 3, 4; pl. 65)

*Range*—Eastern China, Taiwan and Honshu Island, Japan.

*Remarks*—This is the only cool water member of the subgenus *Phalium*. It ranges from Hong Kong northward into the Yellow Sea, skirting the west coast of Taiwan, and extending to both sides of northern Honshu Island, Japan. Literature records of its occurrence in Indonesia and the Philippines are undoubtedly erroneous. It has not been authentically reported from the Ryukyus or Bonin Islands nor farther south than Hainan Island on the south China coast.

The shell is very similar in shape and structure to the tropical *Phalium areola* (Linné), and may well be the northern replacement for *areola*. *P. strigatum* differs only in having 12 to 22 narrow, wavy, axial, yellow-brown stripes extending across the body whorl (instead of square spots), and in having slightly stronger wrinklins and spiral plicae on the columella. Many specimens of *strigatum*, especially immature and dwarf, have pronounced spiral grooves on the last whorl, particularly at the base of the shell. Dwarfs occur in 30 fathom depths in the area of Hong Kong. In Japan, it has been dredged from 1 to 50 fathoms. Dr. Odon Debeaux (1863, Jour. de Conchyl., vol. 11, p. 251) gives the phoenetec equivalent for the Chinese name used in Cheefoo for this shell: An-tse-bo-lo-la.

*Description*—Shell 42 to 110 mm. (about 1-3/4 to 4-1/2 inches) in length, solid, rotund, usually smooth but sometimes spirally grooved, with 3 to 8 (usually 5) varices, colored whitish with 12 to 22 narrow, wavy, axial, yellow-brown stripes on the body whorl, and with strong, spiral wrinklins on the columella. The lowest plica on the columella, well within the aperture, is usually the largest and quite strong. Base of shell usually with a few spiral grooves. In other features, in-



Plate 64. *Phalium menkrawitense* Beets, 1941. Miocene of Mangkal, eastern Borneo, Indonesia. Holotype. 33.2 mm. in length.





Plate 65. *Phalium strigatum* (Gmelin): Holotype of *Cassis zebra* Lamarck. Mus. Geneva. 86.1 mm. in length.

cluding the operculum, very similar to those in *Phalium areola* (Linné). In fresh specimens the varix and left side of the columellar shield has golden yellow blotches.

*Measurements (mm.)—*

		no.	no.	
length	width	whorls	varices	
110.0	70.0	8+	8	large; Wakayama, Japan
91.5	55.5	9	7	average; Chiba, Japan
86.1	54.1	8	5	Lamarck's type of <i>zebra</i>
60.0	38.5	8	3	small; Kaneda, Tokyo, Japan
42.0	26.2	8	4	dwarf; Hong Kong

*Synonymy—*

- 1791 *Buccinum rugosum* Gmelin, *Systema naturae*, ed. 13, pt. 6, p. 3476, no. 27 (locality unknown); refers to Lister, pl. 1014, fig. 78. Non Linné, 1771.  
 1791 *Buccinum strigatum* Gmelin, loc. cit., p. 3477, no. 179 ("in Oceano indico"); refers to Conchyl.-Cab., vol. 10, figs. 1457-1458; vol. 2, fig. 356; Favanne, pl. 24, fig. d.  
 1798 *Cassis rugosa* Röding (in part), *Museum Boltenianum*, Hamburg, pt. 2, p. 31, no. 378 in referring to Lister, pl. 1014, fig. 78 (no locality).  
 1798 *Cassis flammifera* Röding, loc. cit., p. 31; refers to Conchyl.-Cab., vol. 10, figs. 1457-1458.

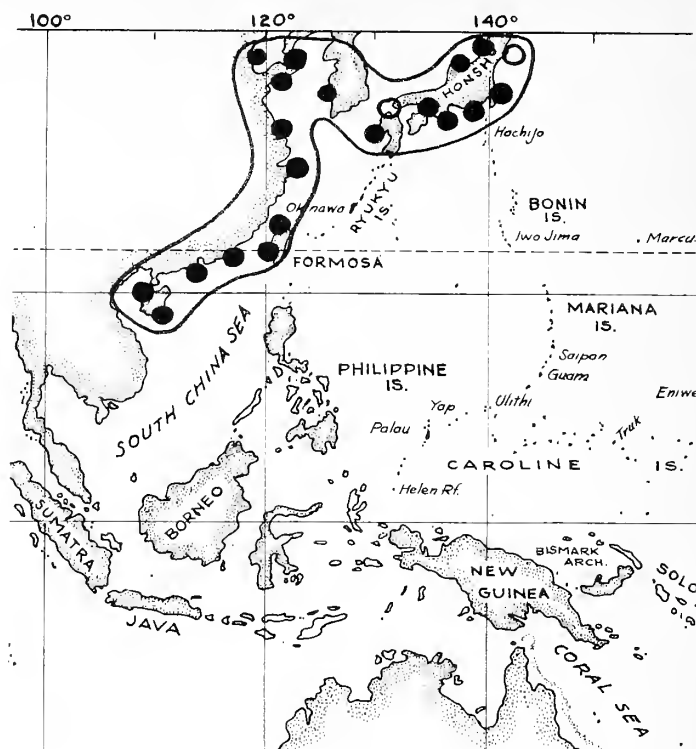


Plate 66. Geographical distribution of *Phalium* (*Phalium*) *strigatum* (Gmelin).

- 1807 *Phalium flammeolum* Link, *Beschreibung der Naturalien; Samml.*, Rostok, pt. 2, p. 112 (no locality); refers to Conchyl.-Cab., vol. 2, figs. 367, 368 and vol. 10, figs. 1457, 1458 (in part).  
 1811 *Cassis variegata* Perry, *Conchology*, London, pl. 33, no. 3 (Eastern Seas).  
 1822 *Cassis zebra* Lamarck, *Anim. sans Vert.*, vol. 7, p. 223, no. 10; refers to Lister, pl. 1014, fig. 78; Conchyl.-Cab., vol. 2, fig. 356a; vol. 10, figs. 1457, 1458 and others (*l'Océan indien et des Moluques*); 1826, Crouch, *Illus. Introd. Lamarck's Conch.*, London, p. 35, pl. 18, fig. 7; 1844, Deshayes, loc. cit., ed. 2, vol. 10, p. 28.  
 1844 *Cassis undata* "Martini" Deshayes, *Anim. sans Vert.*, ed. 2, vol. 10, p. 28 in footnote; 1848, Reeve, *Conch. Icon.*, vol. 5, pl. 10, fig. 26.  
 1935 *Phalium areola* var. *küsteri* Bayer, *Zoologische Mededeelingen*, Leiden, vol. 18, p. 99; refers to Küster, var. A, in Martini and Chemnitz, *Syst. Conchyl.-Cab.*, ser. 2, vol. 3, pt. 1 b, *Cassis*, p. 34 which, in turn, refers to Argenville, pl. 15, fig. D.  
 1935 *Phalium strigatum* (Gmelin), Bayer, *Zool. Mededeel.*, Leiden, vol. 18, p. 100.

*Types*—Gmelin probably did not have a specimen. His species was founded on Lister, pl. 1014, fig. 78. We designate Nagasaki, Japan, as the type locality. Lamarck's type of *Cassis zebra* is in the Lamarck collection in the Geneva Museum of Natural History. His type locality of "*l'Océan indien et des Moluques*" is erroneous. Perry's type of *Cassis variegata* is probably lost and now unlabelled in some private collection.

**Records**—CHINA: Pei-tai-ho, North Chihli (ANSP; Zool. Mus. Copenhagen; USNM); Chin-wang-tao, North Chihli (USNM); Tsingtao, Shantung Prov. (MCZ); Cheefoo, Shantung Prov. (Tomlin coll'n., Nat. Mus. Wales); Chusan Id., Chekiang Prov. (Zool. Mus. Berlin); Amoy, Fukien Prov. (T. -C. Yen, 1933, p. 63); 30 fms., Hong Kong (A. J. Staple, ANSP); Sang-ja and Sin-Tsung, Hainan Id. (A. O. Scarlato, Zool. Inst. Leningrad). TAIWAN: Botau-wan, Takao; Hoko (Kuroda, 1941, p. 104); Tainan (ANSP). KOREA: Techun (J. S. Yoo, 1959, p. 29). JAPAN: Honshu Id.: Oga Peninsula, Akita-ken (K. Hatai, ANSP); Onahama Bay, Fukushima Pref. (Nomura and Kakuta, 1933, Saito Ho-On Kai Mus., special report no. 3, p. 15); Kaneda, Tokyo Bay (C. H. Ames, ANSP); Sagami Bay (C. H. Ames, ANSP); Shimoda Bay (I. Sakai, 1935, Biol. Report of Shimoda Marine Biol. Sta., Tokyo, p. 52); Awaji Id. (MCZ); Yokohama Bay (USNM); Enoshima (ANSP); Kamakura; Wakayama; Chiba (all A. R. Calm coll'n., ANSP); Mikawa (north coast), 20 fms. (W. E. Old, Jr., ANSP). KYUSHU ID.: Nagasaki (USNM); Fukuoka Pref. (Takahashi and Okamoto, 1948, Fukuoka Molluscan Club, Cat. Moll. Shells, p. 14, no. 215).

**Fossil records**—PLIOCENE: Simaziri Beds of Gabusoga, Okinawa Id., a fragment only (Nomura and Zinbo, 1936, Tohoku Imp. Univ. Sci. Reports, series 2, Geology, vol. 18, pt. 3, p. 258).

### *Phalium decussatum* (Linne, 1758)

(Pl. 7, figs. 8, 9; pl. 67)

**Range**—Southeast Asia and Indonesia.

**Remarks**—This uncommon species is very close to *areola* Linné, but is probably a distinct species. It is flattened dorso-ventrally, has a cancellate sculpturing in the adult stage and has two small, white prongs on the upper shoulder of each varix. There are usually 6 to 7 varices in the spire of *decussatum* and usually 3 to 4 (rarely 6) in the spire of *areola* and *strigatum* (Gmelin, 1791). To date, *decussatum* has not been recorded from the Philippines.

That two color forms existed in this species was recognized by early workers, including

Linnaeus himself. In 1773, Martini illustrated the two forms, one with *areola*-like spots, the other with *strigatum*-like longitudinal stripes. The former is Linnaeus' type *decussatum*, the latter being the color form *flammeolum* Röding, 1798. Link's 1807 *Phalium flammeolum* is a mixture of Gmelin's *strigatum* and Röding's color form of *decussatum* (Linné). I dismissed the possibility that *flammeolum* might be a form of *Phalium strigatum* (Gmelin, 1791) because of several differing features in sculpture and shape, and because *strigatum* does not occur in the East Indies. The forma *flammeolum* is rare and seldom seen with locality data in collections.

**Description**—Shell 52 to 70 mm. (2 to 2-3/4 inches) in length, similar to *Phalium areola*, but flattened dorso-ventrally, with a cancellate sculpture on the adult body whorl, and with two, whitish, small prongs on the shoulder of each of the 6 or 7 varices. Two color forms exist, the *typical* forma has 5 or 6 spiral rows of relatively small, square chestnut-brown spots, and a whitish varix with 5 or 6 brown bars. The forma *flammeolum* has 12 to 14 slightly wavy, crowded, axial brown to yellow-brown stripes running the length of the last whorl, and the varix is stained a solid, deep, chestnut- or red-brown. Operculum and soft parts unknown.

#### Measurements (mm.)—

		no.	no.	
length	width	whorls	varices	
70.5	46.0	7 +	6	typical color; Taiwan
67.6	45.6	7 +	7	<i>flammeolum</i> ; Taiwan
65.3	44.0	7 +	7	<i>flammeolum</i> ; no data
65.0	43.5	7 +	7	<i>flammeolum</i> ; no data
52.2	30.5	7 +	6	typical color; Moluccas

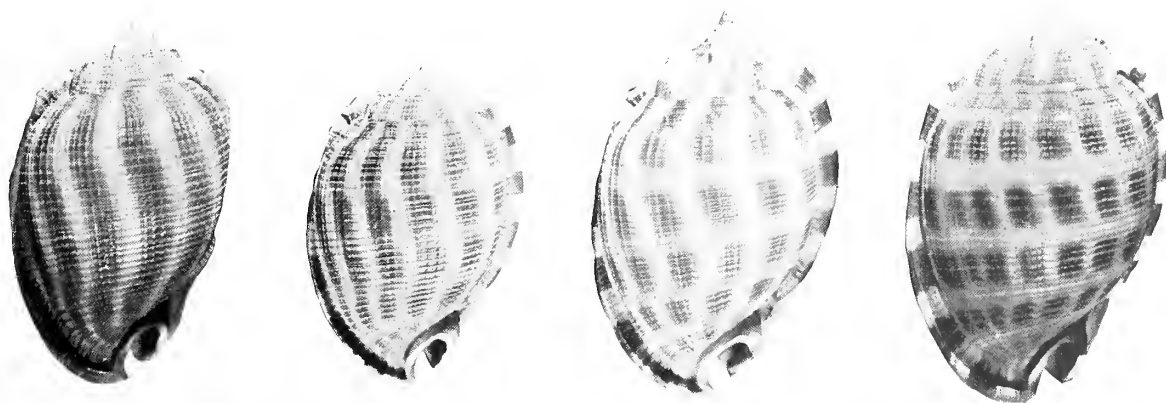


Plate 67. *Phalium (Phalium) decussatum* (Linné, 1758). A series of adults from off Anping, Taiwan, showing variation in size and color patterns from the forma *flammeolum* Röding,

1798, on the far left, and the typical, spotted form in the far right figure. All natural size.

*Synonymy*—

- 1758 *Buccinum decussatum* Linné, *Systema naturae*, ed. 10, p. 736, no. 388 (no locality); refers to Bonanni, vol. 3, pl. 157 and Gualtieri, pl. 40, fig. B; 1767, loc. cit., p. 1119, no. 450 (in O. Africano); 1823, Mawe, *Linn. Syst. Conch.*, London, pl. 24, fig. 1; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 111, p. 181.
- 1792 *Cassidea decussata* Linné, Bruguière, *Encyclop. Méthod.*, Vers, vol. 1, pt. 2, p. 425.
- 1798 *Cassis cancellata* Röding, *Museum Boltenianum*, Hamburg, pt. 2, p. 31; refers to Knorr, pt. 2, pl. 10, fig. 3, 4. Non Röding, *ibid.*, p. 30.
- 1798 *Cassis flammicolum* Röding, *Museum Boltenianum*, Hamburg, pt. 2, p. 31, no. 376; refers to *Conchyl.-Cab.*, vol. 2, figs. 367, 368.
- 1807 *Phalium decussatum* "Gmelin", Link, *Beschr. Natur.-Samml.*, Rostok, pt. 2, p. 112 (refers to Martini, *Conchyl.-Cab.*, vol. 2, figs. 360, 361).
- 1822 *Cassis decussata* Linné, Lamarck, *Anim. sans Vert.*, vol. 7, p. 223, no. 11; 1848, Reeve, *Conch. Icon.*, vol. 5, *Cassis*, pl. 2, sp. and figs. 4a, b, e. d. Not Locard, 1886.
- 1961 *Bezardicella decussata* Linné, Habe, *Coloured Illust. Shells Japan*, pt. 2, p. 43, pl. 20, fig. 7.

*Types*—There is a specimen of the typical, spotted *decussatum* of authors in the Linnaean collection, according to Dodge (1956, p. 183). It is not known if this is the type. The shell far-

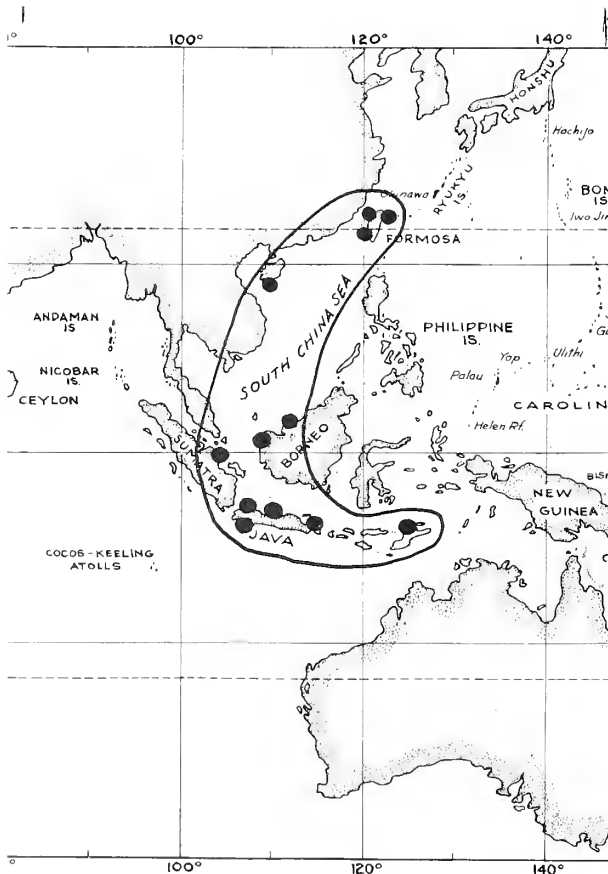


Plate 68. Geographical distribution of *Phalium* (*Phalium*) *decussatum* (Linné).

thest to the right in Gualtieri's pl. 40, fig. B. to which Linné referred is an excellent illustration and should serve as the "type figure" in the event Linné's type specimen is not identified. There was no original type locality, and we now designate the locality of both color forms to Tjilatjap, Java Id., Indonesia.

*Records*—CHINA: Sang-ja and Yen-dzou, Hainan Id. (A. O. Scarlato, *Zool. Inst. Leningrad*, typical forms). TAIWAN: off Tainan (ANSP); Taihoku-syu; Takao (Kuroda, 1941, p. 104). INDONESIA: Pantai Tjermin, Sumatra Id.; Seongeiliat, Banka Id.; Wijnkoobuai, south Java Id. (all *Zool. Mus. Amsterdam*, all typical form). Surabaya and Tjilatjap, Java (both forms); Timor Id.; Tandjoeng Priok, Java Id. (all *Rijkmus. Nat. Hist. Leiden*). Madura, Java (*Mus. Zool. Bogoriense*). Muntok, Banka Id. (*Berlin Mus.*). BORNEO: (west) Mampawa; Pululo, Bintang Id., Sarawak (both *Berlin Mus.*); Sarikei, Sarawak (Franz Steiner, Dec. 1967).

*Fossil records*—Semi-fossil (Pleistocene?) from Surabaya, Java Id., Indonesia (*Rijks. Mus. Leiden*). PLIOCENE: Byoritu Beds of Wangwa, Taiwan (Nomura, 1935, p. 169, pl. 8, fig. 38 (not 24)).

*Phalium cancellianum* Nomura, 1935

(Pl. 69)

*Range*—Pliocene of Taiwan.

*Remarks*—Nomura recorded three species of Pliocene *Phalium* from the Byoritu Beds at Wangwa, Taiwan, namely *P. areola* (Linné), *P. decussatum* (Linné) and this new species. It is possible that *cancellianum* is the young of *decussatum*, but because of its very prominent cancellate sculpturing, I am accepting it as a good species.

*Description*—Shell 30.4 mm. in length, oblong-oval, with a single varix on each mature whorl; test thick and solid; spire short, conical, apex acute. Whorls 8, granular, cancellate, apical 3

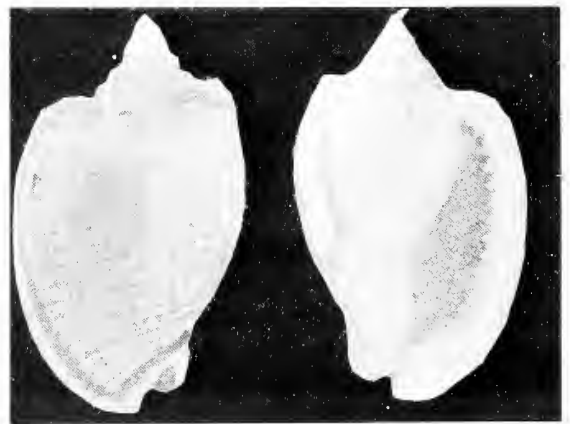


Plate 69. *Phalium cancellianum* Nomura, 1935. Pliocene of Taiwan. Holotype, 31 mm. in length.



(or  $2\frac{1}{2}$ ) embryonal, globular and smooth, the fourth also globular, the rest somewhat shouldered above, regularly convex below and marked with longitudinal ribs crossed by incised spiral grooves; the former about 30, and the latter 17 in number on body-whorl. Aperture narrow, elongate, somewhat tapering above; outer lip thickened by terminal varix, coarsely liriate within; inner lip has more or less punctate-corrugations at the lower part (from Nomura's original).

### Synonymy—

1935 *Phalium (Phalium) cancellium* Nomura, Tohoku Imperial Univ. Science Reports, series 2, Geology, vol. 18, no. 2, p. 169 and 62, pl. 8, figs. 25a, b (Wangwa, Taiwan; Pliocene, Byoritu Beds).

### *Phalium fimbria* (Gmelin, 1791)

(Pl. 7, figs. 1, 2.)

**Range**—Indian Ocean and Indonesia.

**Remarks**—This rare and handsome species, formerly known by some workers as "*plicatum* Linné", has a curious mixture of distinct characters. The sculpturing in the spire and the occasional double row of wart-like denticles on the outer lip are reminiscent of *Cassis tessellata* Gmelin of West Africa; the axial, wavy, yellow-brown bands of color are similar to those of *Phalium strigatum* (Gmelin), but the strong, axial ridges on the body whorl and the highly developed parietal shield are similar to some European Pliocene species. The 3 spines at the base of the outer lip are very poorly developed and may be

absent. Although the species extends half the length of the Indo-Pacific, from Mauritius to Indonesia, it is probably known from less than a hundred specimens. Its habitat is unknown, although specimens are occasionally cast on beaches after a storm.

**Description**—Shell 60 to 113 mm. (About  $2\frac{1}{2}$  to 4 inches) in length, solid, heavy glossy, elongate, with a large, rounded, white parietal shield, with strong, slanting axial plications running  $\frac{3}{4}$  the length of the body whorl, with 6 square, dark-brown spots on both sides of the former varices, and with yellowish brown, wavy, axial flames on the body whorl. Nuclear whorls 3, smooth and white. Post-nuclear whorls with 6 to 10 spiral threads crossed by axial riblets which form small beads at their intersection. Suture bounded below by a swollen, beaded cord. Body whorl with about a dozen strong axial plications which terminate at the shoulders in small nodules. Spire with 3, rarely 4, former varices. Last varix glossy, white, recurved, bearing 6 square brown spots in the gutter on the posterior side, and, on the apertural side, bearing one or two rows of about a dozen denticles, the outermost, when present, consisting of small, round knobs. Parietal shield well developed, rounded posteriorly. Inner half of columella with numerous, weak, broken, raised, white, spiral wrinkles. Interior of aperture whitish to light-brown, the latter usually limited to the anterior section. Base of outer lip with 3 very weak projections. Umbilicus almost completely sealed by a former varix. False umbilicus usually completely sealed or minutely open. Siphonal canal recurved, very short and its left exterior side with a brown blotch. Operculum and soft parts unknown.

### Measurements (mm.)—

		no.	no.	
length	width	whorls	varices	
113.0+	66.0	7+	4	large; Brit. Museum
100.0	49.5	9	5	Moluccas; Manchester Mus.
81.0+	45.0	5+	4	Trincomalee, Ceylon
70.5	39.1	6+	6	Phuket, Thailand
64.0+	37.2	5+	5	Amboina, Indonesia

### Synonymy—

1791 *Buccinum Fimbria* Gmelin, Systema naturae, ed. 13, p. 3479, no. 39 (no locality); refers to Seba, pl. 53, figs. 1, 2; 1817, Dillwyn, Descript. Cat. Recent Shells, London, vol. 2, p. 600, no. 33 (East Indian Seas); 1818, Wood, Index Testaceol., London, p. 105, no. 34.

1798 *Cassis rugosa* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 31, no. 378 (no locality); refers to Conchyl.-Cab., vol. 10, figs. 1459 and 1460 (chosen here as typical) and to Lister, pl. 1014, fig. 78 (which is *strigatum* Gmelin).

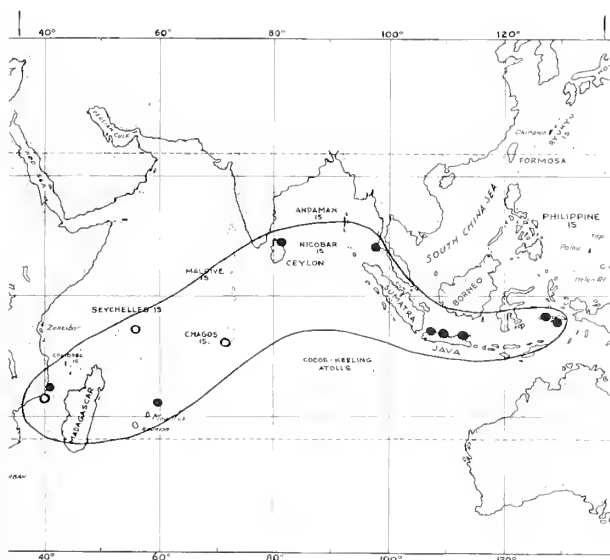


Plate 70. Geographical distribution of *Phalium (Phalium) fimbria* (Gmelin). Open circles are literature records.



- ?1807 *Cassidea tuberculata* G. Fischer, Muséum Demidoff, Moscow, vol. 3, p. 185, no. 23 (locality unknown).  
 1822 *Cassis plicaria* Lamarck, Anim. sans Vert., Paris, vol. 7, p. 222, no. 8 (no locality); refers to Seba, pl. 53, figs. 1 and 2; Knorr, pt. 3, pl. 28, fig. 1; Favanne, pl. 25, fig. D4; Conchyl.-Cab., vol. 10, figs. 1459, 1460; 1835, Kiener, Coquilles Vivantes, Paris, vol. 8, Cassis, p. 14, pl. 6, fig. 11.  
 1840 *Cassidea plicaria*, Swainson, Treatise on Malacology, London, 1840, p. 299; refers to Conchyl.-Cab., vol. 10, figs. 1459, 1460.  
 1844 *Cassis plicata* Linné, Deshayes, Anim. sans Vert., Paris, ed. 2, vol. 10, p. 25, footnote; 1848, Reeve, Conch. Icon., vol. 5, pl. 10, fig. and sp. 27 (Moluccas); 1885, Tryon, Manual of Conchology, Philadelphia, vol. 7, p. 277, pl. 7, fig. 86.  
 1935 *Phalium plicatum* (Linné), Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 100.

**Nomenclature**—Linnaeus' *Buccinum plicatum* was an enigma to the early workers, including Martini (1773), Schröter (1783), Chemnitz (1788), Bruguière (1792) and Dillwyn (1817). Hanley (1855, p. 241) and Dodge (1956, p. 174) both state that Linnaeus did not have a specimen of *plicatum*, that the descriptions in 1758 and 1767 are not diagnostic, that the figure references are a mixture of several species, and that the only recourse is to consider it a *species dubia*. In this I concur, and follow Dillwyn (1817) and Wood (1818, 1825) in using the earliest valid name, *Buccinum fimbria* Gmelin, 1791, for our species here. The unwarranted use of *plicatum* Linné for this species is attributed to Deshayes' specious arguments (1844). He was followed by Reeve (1848) and Tryon (1885) and by the "rule of popularity" the name *plicatum* was carried on by Bayer (1935), Walter F. Webb and Maxwell Smith.

**Types**—It is possible that Gmelin did not have a specimen. No type locality was given. We here-

by designate Trincomalee, Ceylon, as the type locality. We suggest that Seba, vol. 3, pl. 53, no. 1, serve as the "type figure".

**Records**—PORTUGUESE EAST AFRICA: Mozambique City; Porto Amelia (both *vide* K. J. Grosch, 1968). INDIAN OCEAN IDS.: Seychelles (Lienard, 1877, p. 75); Cargados Ids. (Mauritius Inst.); Chagos Ids. (Melvill, 1909, vol. 2, pt. 7, p. 100) CEYLON: Trincomalee (George and Mary Kline, ANSP). THAILAND: Phuket Id., Bay of Bengal (S. Vadavilai, ANSP). INDONESIA: Djakarta and Tjilatjap, Java Id.; Amboina, Ambon Id. (all Rijksmus. Nat. Hist. Leiden); Djumiang, Madura Id., Java Id., and Wijnkoopsbaai, Java Id. (both Mus. Zool. Bogoriense); Moluccas (Manchester Mus.).

**Fossil records**—None reported.

### *Phalium darchiaci* (Noetling, 1895)

(Pl. 71)

**Range**—Oligocene of Minbu, Burma.

**Remarks**—This distinctive fossil species is probably a forerunner of the Recent *Phalium fimbria* Gmelin. The shell is about one inch in length, has the dorso-ventral flattening of *Phalium*, has four former varices in the spire, has a strongly beaded subsutural cord, and has a series of longitudinally compressed, axial nodules on the last whorl which might have, in later geological times, given rise to the curious axial plications found in the Recent *P. fimbria*. Noetling (1895, p. 27) stated that the fossil fragment illustrated by d'Archiac and Haime in 1854 (Deser. des Anim. Fossiles du Group Nummulitique de l'Inde, pl. 31, fig. 1) was this species, but this is questionable. The original description reads:

The species name was originally spelled "*d'archiaci*", but according to the International Commission, 1961, article 32 c (i), the apostrophe should be dropped, the name should be emended to *darchiaci*. I do not consider this a homonym of *Cassis archiaci* Bellardi, 1851. Therefore, Vredenburg's 1921 replacement name of *Cassidea birmanica* is superfluous.

### **Synonymy**—

- 1895 *Cassis d'archiaci* Noetling, Memoirs Geol. Survey India, vol. 27, pt. 1, p. 27, pl. 6, figs. 1, la, lb (Minbu); 1901, Palaeontologia Indica, new series, vol. 1, p. 294, pl. 19, figs. 14a-c (zone of *Cancellaria martiniana*, Minbu).  
 1921 *Cassidea birmanica* Vredenburg, Records Geol. Survey India, vol. 51, pt. 3, pp. 269, 290 (Minbu and Singu; Oligocene).

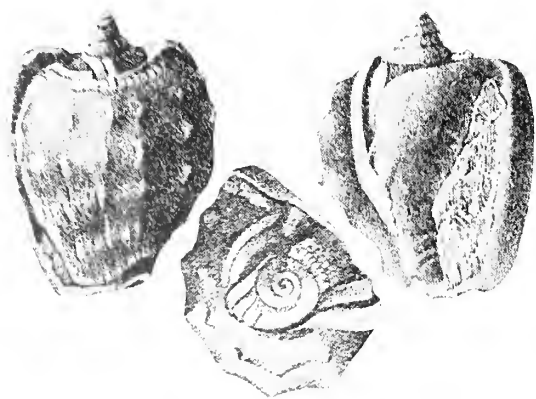


Plate 71. *Phalium darchiaci* (Noetling, 1895). Miocene of Upper Burma. Holotype, 28 mm. in length.

### Subgenus *Echinophoria* Sacco, 1890

Type: *Buccinum intermedium* Brocchi, 1814

Members of this subgenus are characterized by a thin, raised strong thread running along the dorsal surface of the outside of the siphonal canal. It emerges from within the umbilicus and ends at the edge of the siphonal notch. In general, the shells are relatively light in weight, usually white or gray, commonly with small tubercles on the shoulder of the last whorl, always with numerous spiral microscopic threads on the outer surface, and rarely having weak teeth on the white reflected outer lip.

This subgenus had many Tertiary species in Europe and the East Indies. Today, a few widely scattered species live mainly in deep water. The operculum is oval to fan-shaped, horny, and smooth.

The genera *Euspinocassis* Finlay, 1926, and *Shichiheia* Hatai and Nisiyama, 1949, are based upon species with unusually prominent sculpturing.

The name *Echinophoria* should not be confused with *Echinophora* Latreille, 1825, which is a synonym of *Galeodea* Link, 1807 (with type *echinophora* Linné).

**Nomenclature**—There is some doubt as to the validity of Howe's introduction of the generic name *Trachydolium*. Tegland (1931, p. 415) considered the name a *nomen nudum*. I consider it validly, but inadvisedly, introduced. Howe, (1926, p. 303), in discussing Oligocene mollusks of Oregon, proposed "*Trachydolium*, new genus." On page 305 he lists only one species, namely *Trachydolium dalli*, which would be its type by monotypy. Throughout Howe's article many well-known previously described species are mentioned, but without their authors. In

1926, there was known only one gastropod from the Tertiary of Oregon with the name *dalli*, namely *Galeodea dalli* Dickerson, 1917, which had "*Dolium*-like" characters, and to which Howe was most certainly referring. It probably makes little difference whether or not this name is validly introduced, since it is based upon a poorly described, imperfect specimen. The type appears to have characters very close to those of *Echinophoria*, and for this reason I am burying *Trachydolium* in the synonymy of Sacco's earlier genus. *Miogalea* Woodring and Olsson, 1957, was based upon *dalli* Anderson (= *andersoni* Abbott, 1968), and is considered a subjective synonym of *Echinophoria*.

### Synonymy—

- 1890 *Echinophoria* Sacco, Molluschi dei terreni terziari del Piemonte e della Liguria, pt. 7, p. 39 [not *Echinophora* Leske, 1778, a different name]. (type *intermedia* Brocchi, 1814, by Dall's subsequent designation); 1931, Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 251.
- 1926 *Trachydolium* Howe, Pan-American Geologist, vol. 45, no. 4, p. 303, 305 (type by monotypy: *T. dalli* [Dickerson, 1917]).
- 1926 *Euspinocassis* Finlay, Trans. and Proc. New Zealand Inst., vol. 56, p. 230 (type by Powell's 1928, p. 631, subsequent designation: *E. pollens* Finlay).
- 1949 *Shichiheia* Hatai and Nisiyama, Jour. Paleontology, vol. 23, pt. 1, p. 93 (type by original designation: *S. etchensis* Hatai and Nisiyama, 1949. Miocene; Japan).
- 1957 *Bathygalea* Woodring and Olsson, U.S. Geol. Survey, Prof. Paper 314-B, p. 22. Type by original designation: *Cassis coronadoi* Crosse, 1867.
- 1957 *Miogalea* Woodring and Olsson, loc. cit., p. 22. (Type by original designation: *Cassis dalli* Anderson. Miocene).

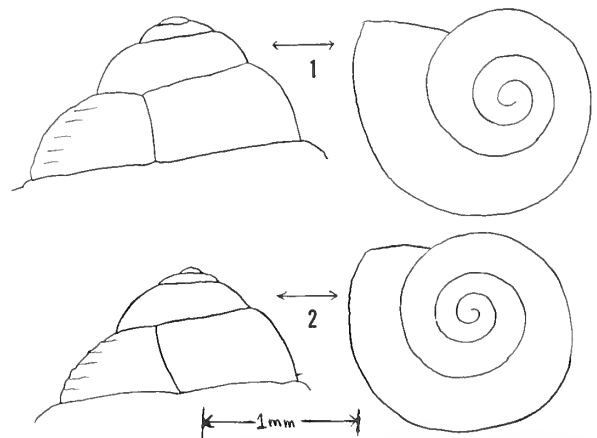


Plate 72. Nuclear whorls of (fig. 1) *Phalium (Echinophoria) pilsbryi* (Woodring and Olsson) and (fig. 2) *P. (Echinophoria) trituberculata* (Weaver).

***Phalium intermedium* (Brocchi, 1814)**

(Pls. 73, 74)

*Range*—Oligocene and Miocene of Italy.

*Remarks*—This is the type of the subgenus *Echinophoria* Sacco. We reproduce the photograph of the lectotype published by Ronchetti in 1953. A large number of minor forms were described by Sacco.

*Synonymy*—

- 1814 *Buccinum intermedium* Brocchi, *Conchiologia Fossile Subapennina*, vol. 2, p. 327 (Piacentino).  
 1817 *Cassis rotundata* DeFrance, *Diction. Sci. Naturelle*, vol. 7, p. 211. Non Perry, 1811.  
 1826 *Cassidaria tuberculata* Risso, *Hist. Nat. Europe Mérid.*, vol. 4, p. 186. Non *Cassidea tuberculata* G. Fischer, 1807.  
 1841 *Cassis quadricincta* Bonelli (MSS), Bellardi and Michelotti, *Memorie della Reale Accad. Scienze Torino*, ser. 2, vol. 3, p. 146 (in synonymy of *variabilis*).  
 1841 *Cassis variabilis* Bellardi and Michelotti, *Memorie della Reale Accad. Scienze Torino*, ser. 2, vol. 3, p. 146 (Colle di Torino, Italy).  
 1877 *Cassis variabilis* var. *tuberculosa* Locard, *Annales Soc. Agri. Hist. Nat.*, Lyon, ser. 4, vol. 9, p. 60, pl. 4, fig. 5, 6 (Casabianda, Corsica). Non Röding, 1798.  
 1890 *Echinophoria variabilis* Bell. and Mich., Sacco, *I Molluschi dei Terremi Terziarii Piemonte Liguria*, pt. 7, p. 43, pl. 1, fig. 43 (Colli torinesi).  
 1890 *Echinophoria variabilis* subvar. *miodenticulata* Sacco; subvar. *elongata* Sacco; subvar. *ampliseriata* Sacco; var. *costata* var. *basicostata* Sacco; var. *transiens* Sacco, all *loc. cit.*, pp. 44-45, pl. 1, figs. 44-46; vars. *unocincta*, *bicincta*, *tricincta*, *quatuorcincta* "Bell. and Micht." Sacco, *loc. cit.*, p. 45.  
 1890 *Echinophoria pliorondoletii* Sacco, *loc. cit.*, p. 43, pl. 1, fig. 42 (Zinola).  
 1890 *Echinophoria intermedia* subvar. *acutitubercula*; subvar. *fasciata*; subvar. *paucidentata*; subvar. *depressa*; subvar. *plioelegans*; var. *subvariabilis* (pl. 1, fig. 47); var. *mioelegans* (pl. 1, fig. 48); var. *stazzanensis* (pl. 1, fig. 49); subvar. *herculea*; var. *subtriseriata* all Sacco, *loc. cit.*, pp. 46-50; var. *tricincta* [sic] "Bell. and Micht.", var. *quinquecincta* "Bell. and Micht." both Sacco, *loc. cit.*, p. 49.



Plate 73. *Phalium (Echinophoria) intermedium* (Brocchi, 1814). Italian Tertiary. Length: 47.6 mm. Lectotype (from Ronchetti, 1953, p. 168, fig. 87). Type of the subgenus *Echinophoria* Sacco, 1890.

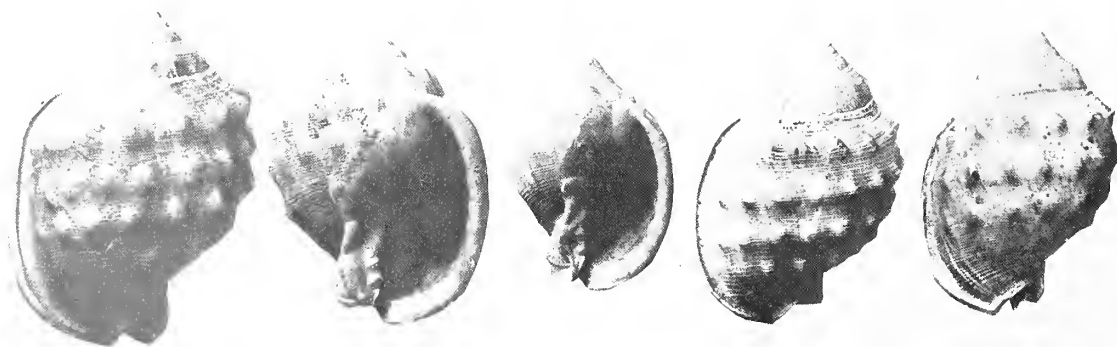


Plate 74. *Phalium (Echinophoria) intermedium* (Brocchi, 1814). Variations in specimens from the Pliocene of Italy.

40-49 mm. in length. (from Sacco, 1904, pl. 20, figs. 25-29).



- 1890 *Echinophoria rondeletii* var. *taurinensis* Sacco (pl. 1, fig. 41); subvar. *colligens* Sacco; subvar. *latiseriata* Sacco, *loc. cit.*, p. 42; 1935, Montanaro, *Paleontographia Italica*, vol. 35, p. 209, pl. 17, fig. 13 (Miocene; Trentino, Italy).
- ?1890 *Echinophoria isseli* Sacco, *loc. cit.*, p. 40, pl. 1, fig. 18 (Oligocene).
- 1940 *Echinophoria intermedia* var. *andreasi* and var. *retifera* Noszky, *Annales Historico-Naturales Muesii Nation. Hungarici*, Budapest, vol. 33, p. 20, pl. 1, fig. 22.
- 1953 *Semicassis* (*Echinophoria*) *intermedia* Brocchi; Ronchetti, *Rivista Italiana di Paleontologia e Stratigrafia*, vol. 59, no. 3, p. 168, fig. 87 (lectotype).

### *Phalium rondeleti* (Basterot, 1825)

(Pls. 75-77)

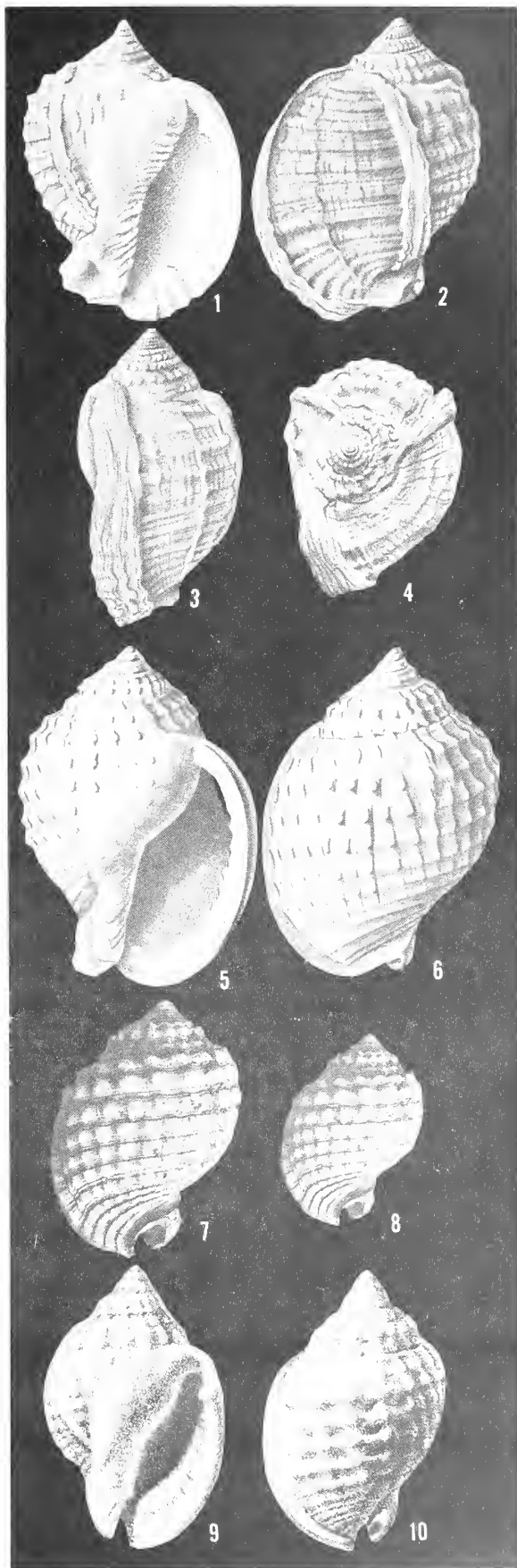
**Range**—Upper Oligocene and Miocene of northern Europe.

**Remarks**—This is a well-known and variable *Phalium* of the Tertiary of Europe which has received a number of names.

#### *Synonymy*—

- 1825 *Cassis rondeleti* Basterot, *Mémoires Soc. Hist. Nat. Paris*, vol. 2, pt. 1, p. 51, pl. 3, fig. 22, pl. 4, fig. 13; 1840, Grateloup, *Conchyliologie Fossile*. . . l'Adour Bordeaux, Atlas, vol. 1, pl. 34, fig. 12; 1863, Speyer, *Die Conchyl. Casseler Tertiärbild.*, vol. 1, p. 288, pl. 35, figs. 6; 1907, Ravn, *Det Konge Danske Vidensk. Selskabs Skrifter*, Copenhagen, ser. 7, vol. 3, no. 2, p. 307, pl. 4, fig. 9 (Jutland).
- ?1825 *Cassis nodosa* König, *Icones fossilium sectiles*, pl. 17, fig. 209 (name and figure only).
- 1861 *Cassis acquinodosa* "Sandberger" Michelotti, *Naturkundige Verhandelingen Hollandsche Maatsch. Wetenschappen Haarlem*, ser. 2, vol. 15, p. 133 (Dego, Mayence; Miocene infér.).
- 1863 *Cassis subventricosa* Speyer, *Die Conchylien der Casseler Tertiärbildungen*, Cassel, vol. 1, p. 50, pl. 4, fig. 14, pl. 5, fig. 8a, b.
- 1863 *Cassis sandbergeri* Speyer, *loc. cit.*, vol. 1, p. 52, pl. 4, figs. 13a, b; pl. 5, figs. 2a-d, 3a.
- 1863 *Cassis multinodosa* Speyer, *loc. cit.*, on pl. 5, figs. 4, 4b.
- 1863 *Cassis elongata* Speyer, *loc. cit.*, p. 54, pl. 5, figs. 6, 7.
- 1863 *Cassis crassinodosa* Speyer, *loc. cit.*, p. 56, pl. 5, figs. 5, 9.
- 1863 *Cassis hertha* "Semper", Speyer, *loc. cit.*, p. 52, 54 (nude name).
- 1863 *Cassis acquinodosa* Sandberger, *Die Conchylien Mainzer Tertiärbeckens*, Wiesbaden, p. 193, pl. 19, figs. 8, 8a (Weinheim near Alzei).
- ?1870 *Cassis vicentina* Fuchs, *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Math.-Nat. Classe*, Wien, vol. 30, p. 148, pl. 1, fig. 5, 6 (Eocene of Vicentin).

Plate 75. *Phalium* (*Echinophoria*) *rondeleti* (Basterot, 1825). Miocene of northern Europe. Figs. 1-4, Miocene of Germany. 48 mm. (from O. Speyer, 1863, vol. 1, pl. 35, figs. 6 a-c). Figs. 5, 6, northern Germany. 50 mm. (from Beyrich, 1854, pl. 10, figs. 4 a, b). Figs. 7, 8, Miocene of Europe. 38 mm. (from Cossmann, 1904, pl. 5, figs. 13). Figs. 9, 10, holotype of *Cassis rondeleti acquinodosa* Sandberger, 1863.





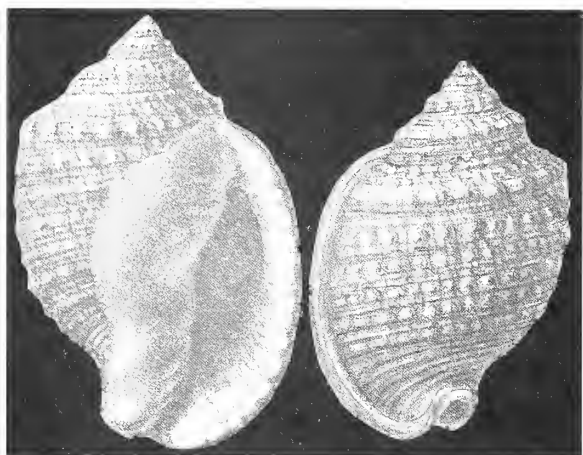


Plate 76. *Phalium* (*Echinophoria*) *scabrida* (Fuchs, 1870). Tertiary of Italy. Holotype, 42 mm. A form or synonym of *rondeleti* (Basterot, 1825).

- ?1870 *Cassis foveolatus* Fuchs, 1870, *ibid.*, p. 214, explanation to pl. 1, figs. 5, 6.  
 ?1870 *Cassis scabrida* Fuchs, *ibid.*, p. 203, pl. 8, figs. 31, 32 (Gnata, near Salcedo; Tertiary).  
 1890 *Echinophoria rondeleti* var. *apenninica* Sacco, I Molluschi Terreni Terziari Piemonte, pt. 7, p. 41, pl. 1, fig. 40 (Tongriano: Dego, Carcare; etc.; Oligocene).  
 1903 *Cassidea* (*Semicassis*) *rondeleti* Bast., Cossmann, Essais Paléoconchologie Comparée, vol. 5, p. 126, pl. 5, fig. 13.  
 1907 *Cassis rondeleti* Basterot, Ravn, Det. Kgl. Danske Videnskabernes Selskabs Skrifter, ser. 7, vol. 3, no. 2, p. 307, pl. 4, fig. 9 (Upper Oligocene, Jutland, Denmark).  
 1924 *Semicassis* (*Echinophoria*) *rondeleti* Basterot, Cossmann and Peyrot, Actes Société Linnéenne Bordeaux, vol. 75, p. 85, pl. 12, figs. 16, 17 (Burdigalien, France).  
 1940 *Echinophoria rondeleti* Bast. var. *longinodosa* Noszky, Annales Historico-Naturales Musei Nation. Hungarici, vol. 33, p. 19.

### *Phalium megapolitanum* (Beyrich, 1854)

(Pl. 78)

**Range**—Oligocene of Denmark and Germany.

**Remarks**—This Oligocene species is extremely close to *rondeleti*, but has been kept separate by Ravn (1907) and Glibert (1963).

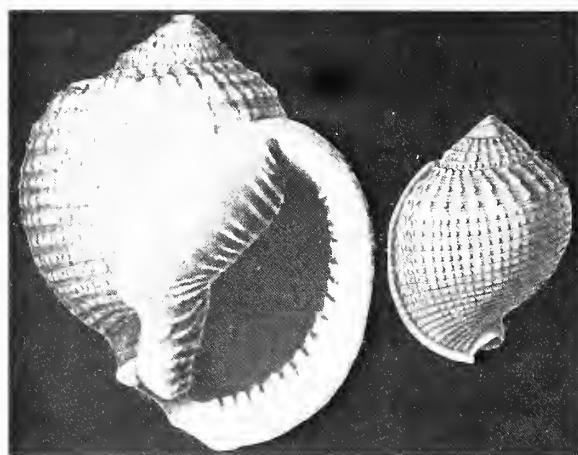


Plate 78. *Phalium* (*Echinophoria*) *megapolitanum* (Beyrich, 1854). **Left fig.**, Oligocene from Denmark. 55 mm. (from Ravn, 1907, vol. 3, pl. 4, fig. 8). **Right fig.**, holotype, from Tertiary of northern Germany. 40 mm. in length. (from Beyrich, 1854, pl. 10, fig. 7).

### **Synonymy**—

- 1854 *Cassis megapolitanum* Beyrich, Zeitschrift der deutsch. geol. Gesell., vol. 6, p. 154, pl. 10, figs. 7, 8; 1907, Ravn, Det. Kgl. Danske Videnskabernes Selskabs Skrifter, ser. 7, vol. 3, p. 308, pl. 4, fig. 8 (Upper Oligocene to Upper Miocene, Denmark).  
 1963 *Semicassis megapolitana* Beyrich, Glibert, Institut Royal Sci. Natur. Belgique, Memoires, ser. 2, fasc. 73, p. 110 (Sternberg, Germany; Chattien, Oligocene).

### *Phalium cancellatum* (von Buch, 1831)

**Range**—Oligocene of northeast Germany.

**Remarks**—This is very similar to *rondeleti* Basterot, 1825, and may be a synonym or subspecies of it. It appears to have a more delicate sculpture and the columellar shield is not well-developed, suggesting an immature specimen. The name is not preoccupied by the secondary homonym, *Cassidaria cancellata* Lamarck, 1822. Röding's 1798 "*Cassis cancellata*" is a synonym of *Phalium decussatum* Linné, 1758, and is considered a *nomen oblitum*.

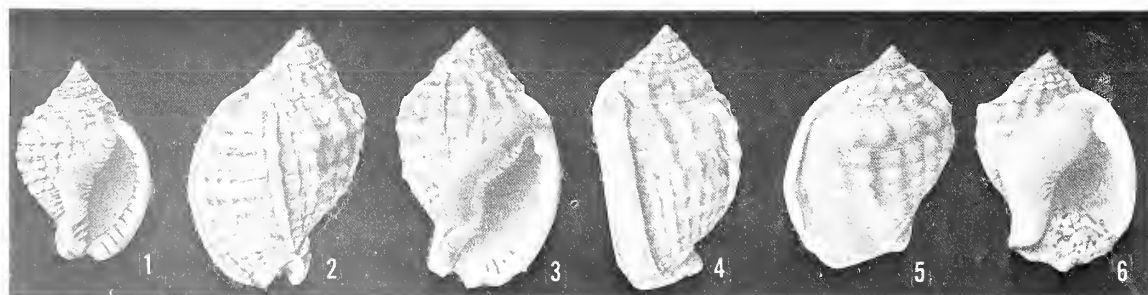


Plate 77. *Phalium* (*Echinophoria*) *rondeleti* (Basterot, 1825). Forma or subspecies from the Miocene of Germany. **Fig. 1**, holotype of *Cassis sandbergeri* Speyer, 1863. 40 mm. **Figs. 2-4**, holotype of *Cassis elongata* Speyer, 1863. 39 mm. **Figs. 5, 6**, holotype of *Cassis crassinodosa* Speyer, 1863. 33 mm.

**Synonymy—**

- 1831 *Cassidaria cancellata* von Buch, Abhandlungen König. Akademie Wissenschaften Berlin, for 1828, p. 63, pl. 4, figs. 1-4 (Tertiary of Mecklenburg, Germany; Oligocene).

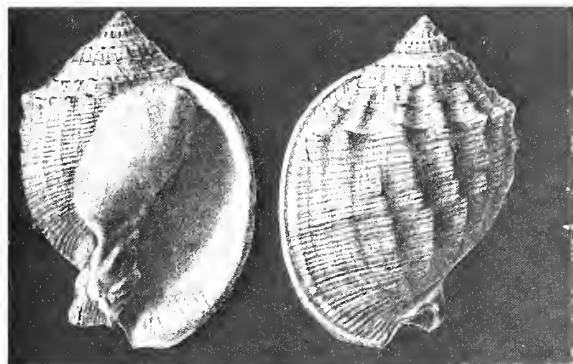


Plate 79. *Phalium (Echinophoria) haueri* (Hoernes and Auinger, 1884). Miocene of Austria. Holotype. 44 mm. in length.

***Phalium haueri* (Hoernes and Auinger, 1884)**

(Pl. 79)

**Range—**Miocene of Austria.

**Synonymy—**

- 1848 *Cassis haueri* M. Hoernes, Verzeichniss in Czjzek's Erläuter. z. geogn. Karte von Wien, p. 18, no. 165. (nude name).  
 1853 *Cassis variabilis* Bell. and Micht., M. Hoernes, Foss. Moll. Tert-Beck von Wien, vol. 1, p. 176, pl. 15, fig. 9.  
 1884 *Cassis (Cassidea) haueri* M. Hoernes, R. Hoernes and Auinger, Abhandlungen der K. K. Geologischen Reichsanstalt, Wien, vol. 12, pt. 4, p. 158, pl. 17, fig. 13 (Lapugy).

***Phalium coronadoi* (Crosse, 1867)**

A number of marine mollusk species live today in both the Caribbean and Indo-Pacific region. Specimens from these widely displaced areas are not separable, as for example those of *Cymatium nicobaricum* Röding and *Tonna galea* (Linné), while others are only sufficiently different, even in minute details, to justify the acceptance of subspecies. *Phalium coronadoi*, originally described from the West Indies, is extremely similar to *wyvillei* of the Western Pacific, and, at best, the latter can only be considered a subspecies. I am excluding the Pliocene Indonesian species, *bituminatum* (K. Martin) from this species because of the strong spiral bands of knobs which beset its entire body whorl; I also exclude the Recent Galapagos *P. pilsbryi* because of the strong, numerous ridges on the center of the columella. Both species, however, are undoubtedly closely related to *coronadoi*.

***Phalium coronadoi*****subspecies *coronadoi* (Crosse, 1867)**

**Range—**Southeast United States and the Greater Antilles; deepwater Recent.

**Remarks—**This large deep-water species is known, so far, from only off North Carolina and Matanzas, Cuba. It doubtlessly occurs in the intervening areas and the Caribbean region in general. The  $3\frac{1}{2}$  to  $4\frac{1}{2}$  inch long shell has three rows of tubercles on the last half of the body whorl, and the spiral sculpturing appears to be much stronger than in the Indo-Pacific subspecies, *wyvillei*. The differences between the Caribbean and Indo-Pacific forms are not as real as Watson (1886) and Woodring and Olsson (1957) claim. Specimens from Indonesia and Japan show spire heights, regularity of nodules, size and coloration closely approximating those of *coronadoi*. The first postnuclear whorls in both races have 5 or 6 spiral threads. The North Carolina specimen is only  $\frac{1}{2}$  inch longer than one from Japan. The spire angles vary from  $89^\circ$  to  $105^\circ$  in *wyvillei*, while in *coronadoi* they are  $100^\circ$  to  $102^\circ$ , indicating that this is probably not a characteristic feature.

**Description—**Adult 88 to 117 mm. (about  $3\frac{1}{2}$  to  $4\frac{1}{2}$  inches) in length, globose, moderately thin-shelled, with small knobs on the shouldered whorls of the spire; umbilicate; whitish gray and with a tan periostracum. Nuclear whorls about 3, followed by spiral sculpturing of 6 to 17 fine threads. Body whorl bearing 9 blunt knobs on the shoulder, and 3 low swellings with obsolete knobs below. Interior of outer lip weakly undulate. Last whorl with numerous, flat-topped, spiral threads. Columellar shield moderately broad and white. Columella irregularly folded. False umbilicus slit-like. True umbilicus narrow and deep. Operculum shaped like a broadly opened fan, chitinous, brownish tan and with weak concentric striae on the exterior side.

**Measurements—**

		no.	angle	
length	width	whorls	of spire	
117.0	82.0	8	$102^\circ$	off North Carolina
99.0	85.0	8	$100^\circ$	holotype, Cuba
88.0	63.5	8	$100^\circ$	off Cape Fear, N.C.

**Synonymy—**

- 1867 *Cassis coronadoi* Crosse, Jour. de Conchyliologie, vol. 15, p. 64, pl. 4, fig. 1, pl. 5, fig. 1 (Matanzas, insulae Cubae).  
 1886 *Cassis (Bezardica) coronadoi* Crosse, Watson, Challenger Report, Zoology, vol. 15, p. 409.



1889 *Gaioidea coronadoi* (Crosse), Dall, Bull. 18, Mus. Comparative Zool., Harvard College, p. 231 (off Cape Fear, North Carolina); 1944, Clench, Johnsonia, vol. 1, no. 16, p. 4, pl. 2.

1957 *Bathygalea (Bathygalea) coronadoi* (Crosse), Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 24, pl. 9, figs. 2, 3.

*Records*—CUBA: Matanzas Bay, Cuba (type locality). NORTH CAROLINA: 124 fms. (227 meters), 40 mi. off Cape Fear, Blake sta. 2603 (USNM); 18-20 fms. Wimble Shoals, off Cape Fear (N.C. Inst. Fish. Research, No. 274).



Plate 80. *Phalium (Echinophoria) coronadoi* subspecies *wyvillei* (Watson, 1886). 100-155 fms. off Tablas Island, Philippines. Holotype. 99 mm. British Museum (Natural History).

***Phalium coronadoi***  
*subspecies wyvillei* (Watson, 1886)

(Pls. 80-82)

*Range*—Japan to Australia at depths of 100 to 567 meters.

*Remarks*—To date, this subspecies has been recorded from seven Western Pacific localities. This deep-water subspecies is very variable in shape, size and sculpturing, and its differences from *coronadoi coronadoi* from the Caribbean are very slight indeed. Comparative remarks are given above.

*Description*—Adult from 99 to 117 mm., about  $3\frac{3}{4}$  to 4 inches in length, globose, moderately light-weight, but strong; umbilicate; with fine spiral threads and a row of low spines on the shoulder. The last whorl may be smooth or bear one or two rows of nodules. Nuclear whorls 3, bulimoid and white. Parietal wall rarely shows a third row of 3 or 4 glazed-over nodes. Varix strong, recurved, smoothish, enamel-white, flaring below and bearing 5 or 6 almost obsolete lirae on the inner edge of the lip. Body-whorl smooth or with numerous, fine, squared-topped threads. Knobs on shoulder variable in size and number. Color yellowish tan to grayish white; rarely rust-stained.

Columella broad, somewhat distorted, white, partially obscuring the deep, narrow umbilicus, and swollen in the middle; lower half may have 2 or 3 lirae. Siphonal notch deep and rather broad. Top of canal with a fine spiral thread. Gutter posterior to siphonal canal moderately deep and rounded in cross-section. Operculum light-or dark-brown, with concentric growth striae. Operculum 27 mm.; aperture of shell, 47 mm.



Plate 81. Operculum of *Phalium (Echinophoria) coronadoi* subspecies *wyvillei* (Watson, 1886). Off Mikawa, Ishikawa Prefecture, Japan. 39.5 mm.

Tentacles cream and with a single, longitudinal, black line on the dorsal surface. Odontophore with about 120 transverse rows of teeth. Formula: 4-1-4; 7; 4 and 1. The center cusp of the rachidian is tri-cusped in the one animal examined from Indonesia.

*Measurements (mm.)—*

length	width	no. whorls	angle of spire	
102.0	74.0	8+	105°	Japan
99.0	64.8	9	89°	holotype, Brit. Mus.
(Woodring and Olsson measurements of type inaccurate)				
94.3	66.5	8+	90°	Japan (with 3 varices)
79.5	53.3	8+	90°	Indonesia, Copen. Mus.
75.6	52.8	9	93°	Philippines, USNM
62.7	47.5	9	92°	Philippines, USNM

*Synonymy—*

- 1886 *Cassia (Bezoardica) wyvillei* Watson, *Challenger* Report, Zoology, vol. 15, p. 408, pl. 14, fig. 13 (Sta. 204A, 100-155 fms. off Tablas Id., Philippines. Type in Brit. Mus.).
- 1944 *Galeodea wyvillei* Watson, *Clench, Johnsonia*, vol. 1, no. 16, p. 4.
- 1957 *Bathygalea (Bathygalea) wyvillei* (Watson), Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 24, pl. 9, figs. 1, 4; pl. 10, figs. 3, 4 (Philippines).
- 1960 *Echinophoria wyvillei dolium* Kuroda (MS), Azuma, A Catalogue . . . Mollusca . . . Shikoku, Japan, p. 30, pl. 1, fig. 7 (nomen nudum).
- 1962 *Echinophoria wyvillei* (Watson), Habe, *Coloured Illus. Shells of Japan*, Osaka, vol. 2, p. 44, pl. 21, fig. 10 (200-500 meters, off Japan).

*Records—*JAPAN: off Mikawa, Ishikawa Pref., Honshu Id., 100 meters (T. Habe). PHILIPPINES: 310 fms. (567 meters), between Cebu and Siquijor, *Albatross* Sta. 5535; 182 fms. (333 meters) off N.W. Mindanao Id., *Albatross* Sta. 5519 (both USNM); 100-115 fms. (183-210 meters), off Tablas Id., green mud, *Challenger* Sta. 204a. (Brit. Mus.). INDONESIA: 300 meters, 40 mi. N.W. of Kep Kai Ids., Banda Sea. Th. Mortensen Sta. 8 (Zool. Mus. Copen.). SOLOMON ISLANDS: (Australian Mus.). AUSTRALIA: from fishtrap, 60-80 fms., off North Solitary Id., Wooli, New South Wales (fide Tom Garrard, *in litt.*, 1963).

***Phalium pilsbryi* (Woodring and Olsson, 1957)**

(Pl. 83)

*Range*—Galapagos Islands, shallow water, Recent.

*Remarks*—This species is known only from the type specimen. The shell was picked up on the beach at Seymour Bay, but may originally have come from moderately deep water. The shell is extremely close to that of *P. wyvillei*, differing only in having finer spiral threads and no axial threads in the early post-nuclear whorls, in having a slightly larger umbilicus, and in having a straighter, heavier columella bearing stronger spiral teeth. This latter feature justifies, I believe, retaining *pilsbryi* as a species, although additional material from intervening areas may show a much closer relationship with *wyvillei*. The shell, as a whole, is not thicker than some specimens of *wyvillei*, and the weak denticulations on the inside of the outer lip are probably not very significant.

*Description (of the holotype)*—Adult shell 66.3 mm. (about 2½ inches) in length. Globose, moderately thick shell, with noduled shoulders, umbilicate, and colored a grayish white. Whorls 8. Nuclear whorls bulimoid, relatively large, four in number, smooth, glossy and slightly tilted, and with a weak break just before the post-nuclear whorls. First post-nuclear whorl with about 8 fine, smooth, spiral threads, increasing to 17 by the penultimate whorl. Midway between the irregularly impressed sutures small white knobs are developed which gradually increase in size and number 12 on the last whorl. The last third of the last whorl descends rather rapidly. Base of body whorl with numerous slightly wavy, fine, somewhat flat-topped threads. Below the row of nodules on the shoulder on the last whorl there are 3 additional spiral rows bearing 3 or 4 nodules each. True umbilicus open and deep; false umbilicus at the base of the columella is slitlike and deep. The white parietal wall is moderately developed below; the upper end is a mere white glaze over the body-whorl. Above the columella and on the body-whorl there are 2 very small, slanting, short teeth. Inner edge of the columella furrowed by about 12 short spiral teeth, the two lower ones being the largest. Outer lip recurved, thin but strong, and its inner edge bears numerous, very indistinct teeth. Inside of aperture white. Siphonal canal bordered above by a rounded shallow channel, and bearing a single thin thread along the dorsal side of its length. End of siphon-

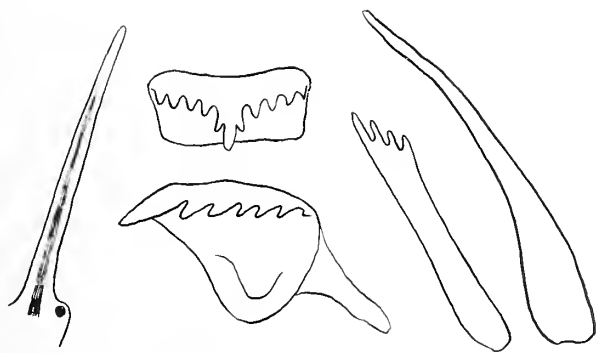


Plate 82. *Phalium (Echinophoria) coronadoi* subspecies *wyvillei* (Watson). Right tentacle and radula of female from the Banda Sea, Indonesia.



al canal deeply notched. Operculum and soft parts unknown.

*Measurements (mm.)—*

length	width	no. whorls	
66.3	47.0	8	holotype ANSP no. 153618



Plate 83. *Phalium (Echinophoria) pilsbryi* (Woodring and Olsson, 1957). Off Galapagos Islands. Holotype. 66.3 mm. in length.

*Synonymy—*

- 1957 *Bathygalea (Bathygalea) pilsbryi* Woodring and Olsson, U.S. Geol. Survey Prof. Paper 314-B, p. 24, pl. 10, figs. 1, 2 (Seymour Bay, Indefatigable Island (Isla de Santa Cruz), Galapagos).

*Types and Records—*See under Synonymy. Known only from the type locality.

*Phalium bituminatum* (K. Martin, 1933)

*Range—*Pliocene, Asphalt beds of Buton Island, Indonesia.

*Remarks—*This species shows such a close resemblance to other members of the subgenus *Echinophoria* that I am assigning it to a position close to *carosum* Kuroda and Habe, 1961. This species has a lower spire and has more pronounced teeth on the inside of the outer lip than does *carosum*, but otherwise is strikingly similar. The type is 28.5 mm. in width. Beets' specimen is 36.7 mm. in length.

*Synonymy—*

- 1933 *Cassidea (Semicassis) bituminata* K. Martin, Leidsche Geol. Mededeel. Leiden, vol. 6, no. 1, pp. 10, 28, pl. 4, fig. 28 (Tertiary, Waisiu, Buton Id., Indonesia).  
1943 *Phalium (Semicassis) bituminatum* (Martin) Beets, *loc. cit.*, vol. 13, no. 1, p. 277, pl. 28, fig. 58 (Waisiu, Buton Id.).

*Phalium vandervlerki* (K. Martin, 1933)

(Pl. 84)

*Range—*Pliocene, Asphalt beds of Buton Island, Indonesia.

*Remarks—*This handsome, 2½-inch-long *Echinophoria* is very close to the Recent deep-water *Phalium wyvillei* Watson, differing only in having two rows (instead of one) of small knobs showing in the penultimate whorl, and in having 6 indistinct (instead of two) spiral rows of nodules showing on the last whorl. The base of the body whorl and the siphonal construction is very close to those in *Phalium pilsbryi* (Woodring and Olsson) from the Recent of the Galapagos. I examined the type in Leiden and was convinced of its close relationship to both the type of *Echinophoria* and other Recent species. K. Martin's paratype (his pl. 4, fig. 28) is another unnamed species. The holotype measures 64 mm. in length, 28.5 mm. in width.

*Synonymy—*

- 1933 *Cassidea (Semicassis) vandervlerki* K. Martin, Leidsche Geologische Mededeelingen, Leiden, vol. 6, no. 1, pp. 10, 27, pl. 4, fig. 27, 28a (Tertiary, Waisiu, Buton [Boeton] Id., Celebes, Indonesia).



Plate 84. *Phalium (Echinophoria) vandervlerki* (K. Martin, 1933). Tertiary, Waisiu, Indonesia. 64 mm. in length.



Plate 85. *Phalium (Echinophoria) bituberculosum* (von Martens, 1901). 1079 meters, off Somalia. Holotype. 45 mm. in length. (from von Martens, 1903, pl. 3, fig. 11).

### *Phalium bituberculosum* (von Martens, 1901)

(Pl. 85)

*Range*—Deep-sea off Somalia, East Africa (1079 meters).

*Remarks*—I have seen only the type of this species which was described from a single specimen dredged in 1079 meters by the "Valdivia". It is a very distinctive shell somewhat resembling *P. inornata* Pilsbry, but is more beaded and has a much smaller umbilicus. The shell appears to be broken at the base of the columella and our placement in the subgenus *Echinophoria* is provisional.

*Description*—Shell 45 mm. (1¾ inches) in length, ovate, pale grayish white in color, and bearing numerous, irregular spiral threads which are finely tuberculate on the slightly angular shoulder. One former varix present on the penultimate whorl. Outer lip with about 23 irregular teeth. Columella shield poorly developed and obliquely sulcate. Whorls 7. Nuclear whorls 3, white, and smooth. True umbilicus chink-like; false umbilicus closed. Length of shell: 45 mm.; width: 30.1 mm.; length of aperture: 35 mm.

### *Synonymy*—

1901 *Cassis bituberculosa* von Martens, Sitzungsberichte Gesellschaft Naturfor. Freunde Berlin for 1901, p. 23 ("Valdivia" station 264); 1903, Wissenschaft. Ergebn. Deutschen Tiefsee-Exped. "Valdivia", vol. 7, pt. A, p. 111, pl. 3, fig. 11.

*Types and Records*—Known only from the type locality: about 100 miles N.N.E. of Obbia, Somalia, in 1079 meters, Globigerina ooze. "Valdivia" station 264, N. Lat. 6°18'; E. Long. 49°32'. The holotype is no. 60052 in the Zoological Museum of Humboldt University in Berlin (1962).

*Fossil records*—None reported.

***Phalium carnosum* (Kuroda and Habe, 1961)**

(Pl. 86)

*Range*—100-200 fathoms, off central Japan.

*Remarks*—This 2½-inch, chalky-white *Phalium* (*Echinophoria*), and its closely related *P. kurodai* Abbott, are unique in having a very reduced columellar shield, and hence lack an umbilicus. In the deepsea *P. bituberculatum* (von Martens) from off East Africa, the columellar shield is midway in development between *carnosum* and *coronadoi* (Crosse). Both species are similar to the *Phalium* (*Echinophoria*) *coronadoi* (Crosse) group, but differ in having several rows of prominent, evenly-sized knobs on the body whorl. In *carnosum*, there are usually 6 rows, while in *kurodai* there are only 5, a feature which appears to be constant. *P. carnosum* is further distinguished by the weakly-pustuled columellar pillar, the numerous, minute spiral threads between the rows of knobs, and the absence of the 5 or 6 prickle-like, small teeth on the base of the outer lip.

*Description*—Adult shell 64 mm. (2½ inches) in length, globular, rather thin-shelled, chalky-white, with a reduced columellar shield, and with 6 rows of rounded knobs. Nuclear whorls 3, bulimoid, white and glossy, but in eroded specimens the nuclear whorls have a tabulate appearance. Postnuclear whorls cancellated by 2 spiral rows of beads, with about 10 smaller, spiral threads, and by fine axial riblets joining the beads. Last whorl with 6 spiral rows of rounded, evenly-sized beads on the upper two-thirds. Base of shell with numerous, fine, raised threads. Upper part of parietal wall with small knobs; columellar shield weakly developed and usually weakly granular and twisted. Outer lip reflected and bearing low, spiral teeth, usually along the entire length. Umbilicus absent. Siphonal canal with a prominent, impressed scar running along the length of its dorsal, outer surface. Color of shell chalky-white, but some specimens with a rose suffusion and a hint of spiral color bands. Operculum chitinous, dark-brown and oval.

*Measurements (mm.)*—

length	width	no. whorls	
64.5	44.1	8	off Tosa, Japan
62.8	42.5	8	off Tosa, Japan
53.2	34.7	—	holotype

*Synonymy*—

1960 *Echinophoria carnosus* Kuroda (MS) Azuma, A Catalogue . . . Mollusca . . . Shikoku, Japan, p. 30, pl. 3, fig. 9 (nomen nudum).

1961 *Echinophoria carnosus* Kuroda and Habe, in Habe, Coloured Illus. Shells of Japan, vol. 2, p. 44, pl. 21, fig. 11, and appendix p. 16 (250-300 meters, off Tosa, Japan); 1961, Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Echinophoria* plate, figs. 2, 3 and 8 (not 1).

*Records*—JAPAN: 200 fms., off Tosa, Shikoku Id. (part of type lot from A. R. Cahn coll., ANSP); 170 fms., off Tosa (ANSP); 250-300 meters, off Tosa (Habe, 1961, app. p. 16).

*Fossil records*—None reported.



Plate 86. *Phalium* (*Echinophoria*) *carnosum* (Kuroda and Habe, 1961). **Top shell:** part of type lot from 200 fathoms, off Tosa, Japan; 62.9 mm. in length; ANSP no. 253339. **Bottom figure:** 64.8 mm. in length, 170 fathoms off Tosa, Japan. Both from the Alvin R. Cahn collection at the ANSP.



**Phalium kurodai** *new species*, Abbott

(Pl. 87)

*Range*—Tosa Bay, Shikoku Id., Japan.

*Remarks*—I take pleasure in naming this new species after the distinguished Japanese malacologist, Tokubei Kuroda, who gave it a manuscript name of *galeodiformis* several years ago. This *Echinophoria* is closely related to *carnosum* Kuroda and Habe, but differs in having 5 (instead of 6) spiral rows of knobs on the body whorl, in having a narrower and smoother columellar pillar, in lacking the densely-packed, spiral threads, and in having only one spiral row of nodules in the early whorls of the spire. The lower part of the outer lip has 7 to 10 small, blunt prickles. Neither *kurodai* nor *carnosum* should be confused with the similar-appearing *Galeodea echinophorella* Hirase, 1934, or *Galeodea leucodoma* Dall, 1907, both of which have a slot-less, unrecurved siphonal canal and loosely-coiled nuclear whorls.

*Description*—Adult shell 56 to 68 mm. (2½ inches) in length, globular, rather thin-shelled, but strong, yellowish white, with a very reduced columellar shield, and with 5 rows of rounded nodules. Nuclear whorls 3, bulimoid, white and glossy, but in eroded specimens the nuclear whorls have a tabulate appearance. Postnuclear whorls with weak, spiral threads, the one midway between the sutures bearing rather large, evenly-sized nodules. Last whorl with 5 spiral rows of whitish, rounded nodules. Base of body whorl smoothish or with very weak spiral threads. Upper part of parietal wall thinly glazed and with 3 rows of nodules. Columellar pillar narrow, glossy white and strongly twisted. Siphonal canal recurved, slotted, and with a thin, narrow, raised line running longitudinally along its dorsal, outer surface. Outer lip slightly recurved and bearing 5 to 12 small, prickle-like teeth on the outer edge of the lower third. Outer lip with weak, brown spots in some specimens which exhibit weak, spiral, narrow bands of brownish orange. Umbilicus absent. Operculum unknown.

*Measurements (mm.)—*

length	width	no. whorls	
68.0	47.2	7+	holotype, off Tosa, Japan
64.7	42.5	7	paratype, off Tosa, Japan
59.5	40.0	7+	paratype, off Tosa, Japan
57.0	40.0	7+	paratype, off Tosa, Japan

*Types*—The holotype, originally a gift by Dr. Alvin R. Cahn to the Academy of Natural Sciences of Philadelphia, has been given to the

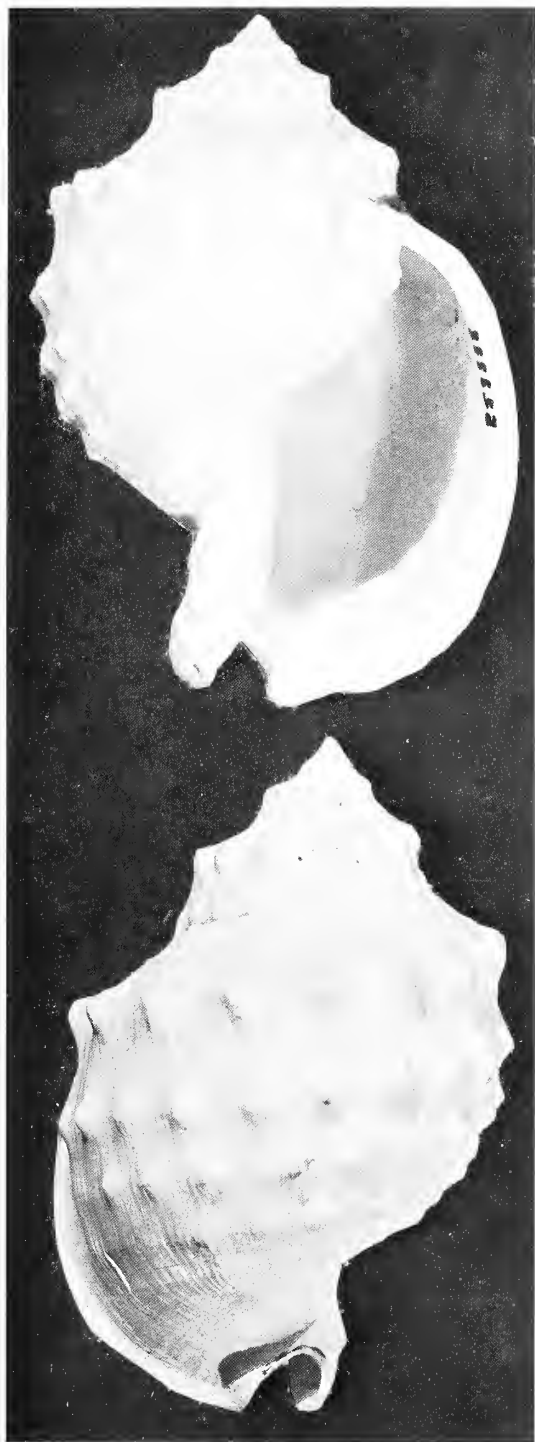


Plate 87. *Phalium (Echinophoria) kurodai* Abbott *new species*. 120 fathoms, off Tosa Bay, Shikoku Island, Japan. **Top figure:** holotype, 68.0 mm., deposited in the National Science Museum, Tokyo, Japan. **Lower figure:** paratype, 67.5 mm. in length; Tosa Bay, Japan. ANSP no. 253338.

National Museum in Tokyo, Japan. The type locality is 120 fms., Tosa Bay, Shikoku Id., Japan. Four paratypes from 100 fms., Tosa Bay, Japan are in ANSP no. 241694.

*Synonymy*—

- 1961 *Echinophoria* sp., Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Echinophoria* plate, figs. 1, 6 and 7 (not 8).  
 1960 *Echinophoria galeodiformis* Kuroda (MS) Azuma, A Catalogue . . . Mollusca . . . Shikoku, Japan, p. 30, pl. 3, fig. 10 (nomen nudum).

***Phalium etchuense* (Hatai and Nisiyama, 1949)**

(Pl. 88)

*Range*—Miocene of Japan.

*Remarks*—This species closely resembles some of the Tertiary *Echinophoria* of Indonesia and is not unlike the Panamanian Pliocene *hadrum* (Woodring and Olsson, 1957). The single known specimen appears to have been poorly preserved, and has lost its siphonal canal. The genus *Shichiheia*, based upon this species, is not distinguishable from *Echinophoria*.

*Description*—(from Hatai and Nisiyama, 1949). Shell thin, oval, moderate in size, with six whorls, separated by appressed sutures; the first two nuclear whorls apparently smooth, rounded; spiral sculpture commencing on the third whorl, where six smooth, revolving flat cords, much wider than the interspaces, are found; tuberculation commences with later growth; fifth whorl with about ten primary and about seven secondary spirals, narrower than interspaces; body-whorl with three rows of tubercles and early stage of a fourth row; all whorls roundly shouldered; varix on last whorl fairly strong, extending to columella; callus deposit thin and wide-spread; canal short and twisted, with distinct folds; outer lip crenulated. Height of holotype 39.5 mm., diameter 29.0 mm.

*Type locality*—Kami-Shin, Kurosedani-Mura, Nei-Gun, Toyama-Ken, Honshu Id., Japan. Susahara formation, Miocene. The holotype is in the Institute of Geology and Palaeontology, Tohoku University, Sendai, no. 72518.

*Synonymy*—

- 1949 *Shichiheia etchuensis* Hatai and Nisiyama, Jour. Paleontology, vol. 23, pt. 1, p. 94, pl. 24, figs. 1, 2, 7.

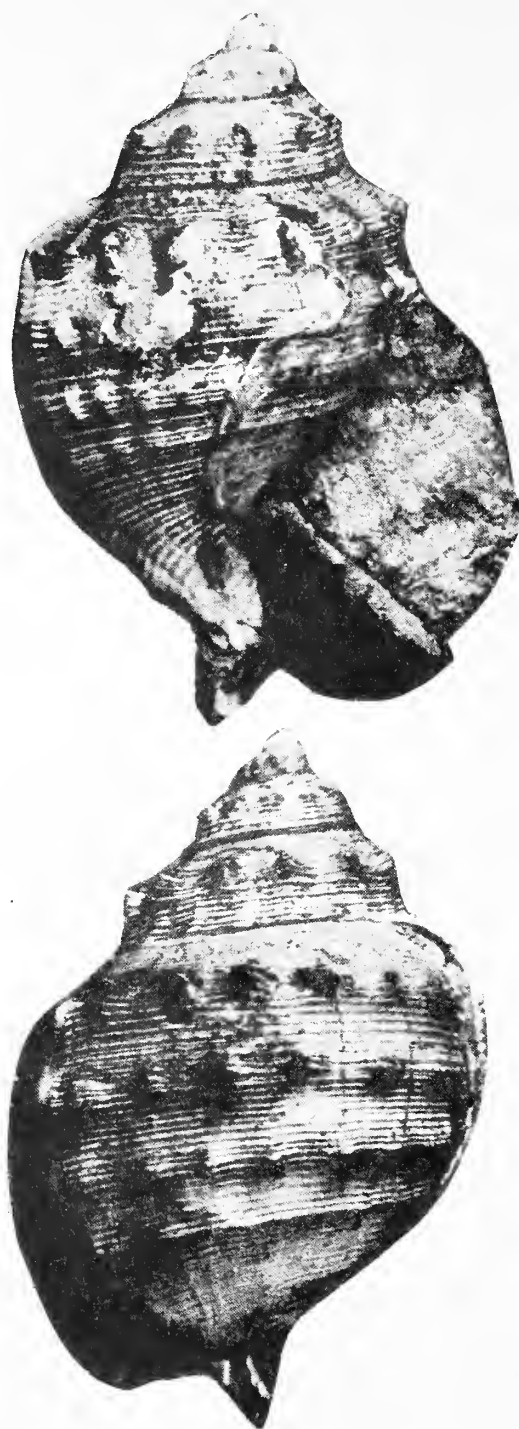


Plate 88. *Phalium (Echinophoria) etchuense* (Hatai and Nisiyama, 1949). Miocene of Japan. Holotype from Hatai and Nisiyama, 1949. 39.5 mm. in length.

**Phalium andersoni new name, Abbott**

(Pl. 89, figs. 1, 2)

**Range**—Early Miocene, Caribbean coast of Colombia.

**Remarks**—Originally described as *Cassis* (*Phalium*) *dalli* Anderson, 1929, and later made the type of *Bathygalea*'s subgenus *Miogalea* by Woodring and Olsson in 1957, this species undoubtedly belongs in the subgenus *Echinophoria*. This makes *dalli* Anderson, 1929, a secondary homonym of *Phalium dalli* (Dickerson, 1917) from the Oligocene of the Pacific Northwest. I do not consider the smaller size (49 mm.), thicker shell, supposedly more sharply pointed knobs and supposedly stronger spiral sculpturing (all of which can be found in some combination in various *Echinophoria*) sufficiently different to justify the recognition of *Miogalea*. *Phalium hadra* (Woodring and Olsson, 1957) from the early Pliocene of the Caribbean side of Panama was also placed in *Miogalea* by those two authors, but it shows even closer affinities with other fossil *Echinophoria* and some living species, such as *pilsbryi* from the Galapagos.

**Description** (from Woodring and Olsson, 1957) —“Thick-shelled. Varix on body whorl preceding the terminal varix generally absent, but present on one specimen [an adult]. Body whorl bearing 10 or 11 sharply pointed knobs on shoulder. Three low swellings on body whorl below shoulder bearing low blunt knobs on early part of whorl. Outer lip, parietal callus and shield very thick. Interior of outer lip bearing long straight ridges. Height: 49.5 mm.; diameter: 39.5 mm.”

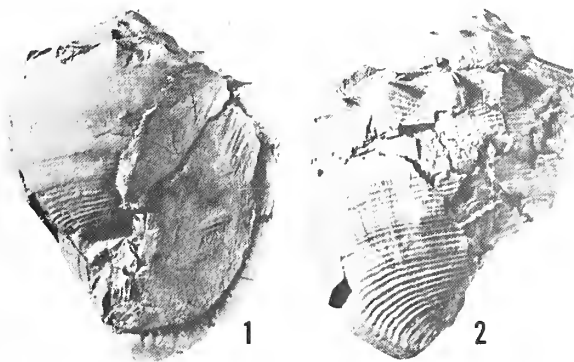


Plate 89. Figs. 1, 2, *Phalium* (*Echinophoria*) *andersoni* Abbott new name, Miocene of Colombia. 49 mm. Figs. 3, 4, *Phalium* (*Echinophoria*) *hadrum* (Woodring and Olsson,

**Synonymy—**

1929 *Cassis* (*Phalium*) *dalli* Anderson, Proc. Calif. Acad. Sci., 4th series, vol. 18, no. 4, p. 141, pl. 14, figs. 10-13 (one mile or more west of pier at Puerto Colombia, Dept. Atlantico, Colombia, Las Perdices shale; type in Calif. Acad. Sci. no. 4649). Not *Phalium dalli* Dickerson, 1917.

1957 *Bathygalea* (*Miogalea*) *dalli* (Anderson), Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 23, pl. 7, figs. 1-4; pl. 8, figs. 3, 4 (3.5 mi. west of Puerto Colombia; Olsson locality 294).

**Phalium hadrum (Woodring and Olsson, 1957)**

(Pl. 89, figs. 3, 4)

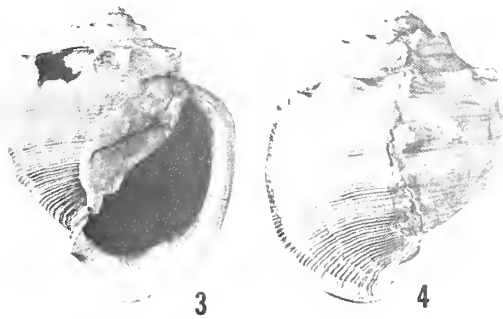
**Range**—Early Pliocene, Caribbean coast of Panama.

**Remarks**—This species appears to be quite closely related to *andersoni* Abbott (new name for *dalli* Anderson), but has a thinner shell, correspondingly thinner outer lip, parietal callus and shield, and weaker ridges on the interior of the outer lip. The rows of knobs and fine spiral sculpturing are typically *Echinophoria*.

**Description** (from the original)—“Moderately thick-shelled. Varices absent, except for terminal varix. Protoconch worn, consisting of about 3 whorls. Body whorl bearing 10 sharply pointed knobs on shoulder. Three low swellings on body whorl below shoulder bearing lower blunt knobs on early two-thirds of whorl. Outer lip moderately thick; its interior bearing short moderately strong ridges. Parietal callus and shield thin. Siphonal canal and siphonal fasciole missing. Insertion of siphonal canal wide. Height: 43.7 mm.; diameter: 33.6 mm. (type).”

**Synonymy—**

1957 *Bathygalea* (*Miogalea*) *hadra* Woodring and Olsson, U.S. Geol. Survey Prof. Paper, 314-B, p. 23, pl. 8, figs. 1, 2 (USGS 8437, Caribbean coast at mouth of Rio Indio, Colon Province, Panama, Chagres sandstone, early Pliocene. Type in USNM 562268).



1957). Pliocene of Panama. Holotype, 43.7 mm. (all from Woodring and Olsson, 1957, pl. 8).



***Phalium apenes* (Woodring, 1959)**

*Range*—Late Oligocene of the Canal Zone.

*Remarks*—This poorly preserved specimen may be a *Tylocassis*, but I am keeping it in *Echinophoria* as originally suggested by Woodring.

***Synonymy*—**

1959 *Semicassis* (*Echinophoria*) *apenes* Woodring, U.S. Geol. Survey Prof. Paper 306-B, p. 198, pl. 26, figs. 11, 17 ( . . . Bohio Ridge station, Canal Zone, Late Oligocene).

***Phalium woodringi* (Olsson, 1964)**

(Pl. 90)

*Range*—Known only from the Pliocene of Ecuador.

*Remarks*—This species is interesting because it bears small *Tylocassis*-like pustules on the lower part of the parietal shield. The left edge of this shield has a strong U-shaped indentation resembling that found in some Australian *Xenophalium*. Technically, the validity of this new species could be questioned, since the author does not compare it with other known species.

*Description* (from original)—Of medium size, rather thinly textured, the body whorl roundly inflated so that it forms most of the surface, the spire relatively low, conic, composed of about six whorls, the apical ones corroded except on

the smallest specimens. Varices behind the terminal one absent; former halts in shell growth may show occasionally as deep sharp lines across the face of the whorl. The protoconch is relatively large, naticid, composed of about three closely-wound smooth whorls. The whorls have a small shoulder, a little above the widest section of the body whorl, and are neatly ornamented with small nodes (about 15 on the last whorl); these small nodes present also on the whorls of the spire. Small or medium-sized shells have but a single row of nodes, that on the shoulder, but the larger specimens show a second row just below or round the widest section of the body whorl, this row passing into the suture does not appear on any of the spire whorls; in addition, the whole surface is covered with close, regular, medium-sized, spiral threads. The aperture is semilunate, the outer lip thickened externally by a varix, its edge raised and somewhat reflexed, the inner side of the lip smooth or with faint lirae in its lower part. The parietal wall has a thin, spreading and closely appressed coat of callus, smooth or with weak lirations within; below, the callus coat is thicker, narrower, generally covered by a sprinkling of small denticles and short lirae, and forms a free-edged shelf which overhangs an umbilical-like opening formed by the entrance of the deep, fasciolar groove encircling the small beak. The siphonal canal carries a deep notch, recurved at the end forming a small beak, its growth trace producing a flat fasciole edged by a small, sharp keel.

Height 36.3 mm., diameter 29.4 mm. Que. Camarones. Holotype, USNM 644057; height 38.5 mm., diameter 31.4 mm. Que. Camarones. Paratype, USNM 644058; height 49.7 mm., diameter 37.4 mm. Punta Gorda. Paratype, USNM 644059.

Probably a deep-sea species. It is fairly common in Quebrada Camarones, less so at Punta Gorda. Named as a tribute to Dr. W. P. Woodring, Tertiary Paleontologist of the United States Geological Survey.

***Synonymy*—**

1964 *Echinophoria woodringi* Olsson, Neogene Mollusks from Northwestern Ecuador, Paleo. Research Inst., Ithaca, p. 170, pl. 30, figs. 8, 8a (Quebrada Camarones, Ecuador).

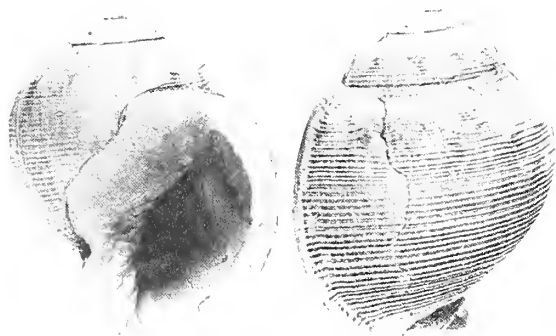


Plate 90. *Phalium* (*Echinophoria*) *woodringi* (Olsson, 1964). Holotype from Quebrada Camarones, Ecuador. Esmeraldas formation, Miocene. Holotype in USNM no. 644057; length: 36.3 mm.

**Phalium tuberculiferum (Hupé, 1854)**

(Pl. 91, figs. 1-3)

*Range*—Tertiary of Chile.

*Remarks*—This species appears to be very close to the Pliocene *Phalium hadrum* Woodring and Olsson, 1957, and the Recent *P. pilsbryi* Woodring and Olsson, 1957. Hupé's specimen lacks a well-developed, lower parietal shield which might indicate a not fully matured individual.

*Synonymy*—

1854 *Cassidaria tuberculifera* Hupé, in Gay's *Historia física i política de Chile*, Zoologica series, vol. 8, p. 209, Atlas, pl. 3, figs. 2, 2a (Coquimbo; Tertiary).

1887 *Cassis tuberculifera* Hupé, Philippi, *Die Tertiären und Quartären Versteinerungen Chiles*, Leipzig, p. 69, pl. 8, fig. 2 (Navidad, Lebu and Llancahue, Chile).

**Phalium taitii (Conrad, 1834)**

(Pl. 92)

*Range*—Eocene of Alabama, Mississippi and Louisiana.

*Remarks*—This species could be placed in either the subgenus *Echinophoria* or *Semicassis*.

*Synonymy*—

1834 *Cassis taitii* Conrad, *Jour. Acad. Nat. Sci. Philadelphia*, vol. 7, p. 145 (Claiborne, Alabama; Eocene); 1899, Johnson, *Proc. Acad. Nat. Sci. Philadelphia*, vol. 51, p. 77, pl. 2, fig. 5.

1937 *Phalium taitii* Conrad, Palmer, *Bull. Amer. Paleontology*, vol. 7, no. 32, p. 251, pl. 83, fig. 10.

1947 *Phalium taitii johnsoni* Palmer, *Bull. Amer. Paleontology*, vol. 30, no. 117 (sec. 2), p. 328, pl. 42, figs. 12, 13 (Moody Branch marl, Jackson, Miss.; Eocene).

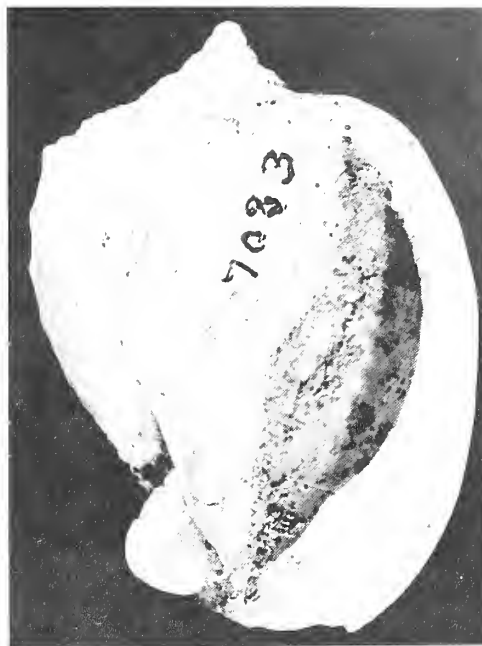


Plate 92. *Phalium (Echinophoria) taitii* (Conrad, 1834). Eocene of Jackson, Mississippi. C. W. Johnson, leg. 1894. Length: 36 mm. ANSP no. 7083.

**Phalium trituberculatum (Weaver, 1912)**

(Pl. 93)

*Range*—Upper Eocene of Washington State and California.

*Remarks*—This is a well-known, small *Echinophoria* closely resembling the type of the subgenus. It has been amply illustrated by Weaver (1942), Schenck (1926) and Tegland (1931). Apparently this species was first described with a brief description in 1855, and a poor illustration

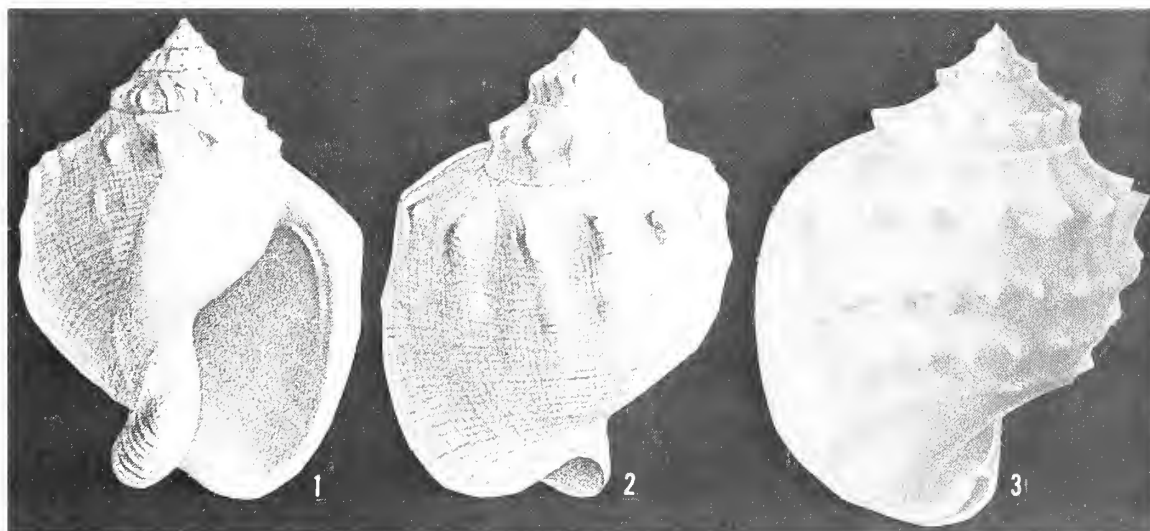


Plate 91. *Phalium (Echinophoria) tuberculiferum* (Hupé, 1854). Tertiary of Chile. Figs. 1, 2, holotype of *Cassidaria*

*tuberculifera* Hupé. 55 mm. Fig. 3, specimen 54 mm. in length (from Philippi, 1887, pl. 8, fig. 2).



Plate 93. *Phalium* (*Echinophoria*) *trituberculatum* (Weaver, 1912). At bend of Cowlitz River, 1.5 miles east of Vader, Lewis Co., Washington. Walter J. Eyerdam collection.

in 1857 by Conrad as *Stramonita* (*Purpura*) *petrosa*. Schenck (1926) and Anderson and Hanna (1925) concluded, correctly we believe, that Conrad's species is the same as *trituberculata* Weaver, 1912. Conrad's earlier name cannot be used because it is a secondary homonym of *Phalium* (*Mauicassis*) *petrosus* (Conrad, 1849).

The four nuclear whorls of *trituberculatum* are smooth, bulimoid and rounded like those of other *Echinophoria*, and not as Weaver and Schenck must have assumed, like *Galeodea*.

#### Synonymy—

- 1855 *Stramonita petrosa* Conrad, U.S. House Document no. 129, appendix, art. 1, p. 17, 18 (Tulare Valley); 1856, U.S. Pacific Railroad Survey, vol. 5, pt. 2, art. 2, p. 327, no. 48, pl. 6, figs. 47, 47a (Tulare Valley). [Tejon Eocene, south end of San Joaquin Valley, Calif.].

- 1912 *Morio tuberculatus* Gabb var. *tri-tuberculatus* Weaver, Wash. Geol. Survey, Bull. no. 15, pp. 39, 40, pl. 3, figs. 35 (north bank of Cowlitz River, 1.5 mi. east of Vader, Lewis Co., Wash.).
- 1922 *Galeodea tri-tuberculata* (Weaver), Weaver and Palmer, Univ. Wash. Publ. Geol., vol. 1, p. 37, pl. 11, figs. 23, 27; 1925, Anderson and Hanna, Occ. Papers, Calif. Acad. Sci., no. 11, pl. 10, figs. 2, 3; 1931, Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, pp. 408, 409, pls. 59, 60; Weaver, 1942, Univ. Wash. Publ. Geol., vol. 5, p. 404, pls. 78, 79.
- 1926 *Galeodea petrosa* Conrad, 1857 [1855], Schenck, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 16, no. 4, p. 82, pl. 14, figs. 5-11. Not *petrosus* Conrad, 1849.

#### *Phalium dalli* (Dickerson, 1917)

*Range*—Oligocene of Washington State, U.S.A.

*Remarks*—I have not seen the type of this species, but subsequent to its first poor description, Durham (1944, p. 166; 1942, p. 185) obtained specimens from the Lower Oligocene, Quimper sandstone, Discovery Bay, Jefferson County, Washington. I follow Durham in placing it in *Echinophoria*, although Durham considered *Echinophoria* as a genus, rather than as a subgenus of *Phalium*. Unfortunately, this creates a homonym of *Phalium dalli* (Anderson, 1929). The latter name can be protected, if one wishes to follow Woodring and Olsson's 1957 placement of Anderson's species in *Bathygalea* (*Miogalea*). I consider the latter two generic names as synonyms of *Phalium*, subgenus *Echinophoria*. This is Rutsch's view (1931, p. 251).

Tegland (1931, p. 410) says that this "seems to be a distinct species but too much weight cannot be placed on the specific characters of a single immature shell, and its relation to the Eocene and to other Oligocene species is not clear." *Phalium fax* Tegland may be this species according to Effinger (1938, p. 382).

Although technically debatable, *dalli* Dickerson may be considered the type of *Trachydolium* Howe, 1926.

#### Synonymy—

- 1917 *Galeodea dalli* Dickerson, Proc. Calif. Acad. Sci., series 4, vol. 7, p. 176, pl. 30, fig. 8a (but not 8b, a portion of the body whorl of *Siphonalia packi* Dickerson, fide Effinger, 1938, p. 382). (Locality 181, near Vader, Lewis Co., Washington, east bank of Cowlitz River; Oligocene); 1931, Tegland, Univ. Calif. Bull. Dept. Geol. Sci., vol. 19, no. 18, p. 410 (Gries Ranch, Wash.); 1938, Effinger, Jour. of Paleontology, vol. 12, no. 4, p. 382 (Gries Ranch).
- 1942 *Echinophoria dalli* (Dickerson), Durham, Jour. of Paleontology, vol. 16, no. 2, p. 185, pl. 29, fig. 4, pl. 30, fig. 5.



**Phalium oconnori (Dell, 1952)**

*Range*—Upper Miocene, Hurupi Beds, New Zealand.

*Remarks*—This is another of the several *Echinophoria* species which are extraordinarily alike, and may eventually have to be synonymized. This one is very close to Powell's *multinodosum* and Laws' *emilyae*. Dell's original description reads:

"Shell fairly large, suboval, inflated, non-umbilicate. Spire moderately high, more than half the height of aperture in adult specimens. Spire whorls obtusely angled, shoulder slightly concave, broad. Body whorl with concave shoulder, inflated below, base broadly convex contracting to strong twisted columella which bears a well marked fasciole. Sculpture on spire whorls consists of a row of well marked, strong, sharp nodules on shoulder. Penultimate whorl with an additional row emerging from lower suture. Body whorl with two additional lower rows. Nodules on body whorl fairly sharp and well marked. Suture strongly impressed, with a well-developed subsutural cord crossed by strong, oblique growth lines. In addition there is well marked spiral sculpture of raised, somewhat flexuous threads, fine on the shoulder, becoming obsolete over the nodules and very well developed on base, the whole crossed by close-spaced growth lines. Outer lip damaged in all available specimens. Inner lip with thin layer of callus. Columella damaged in all specimens but there is a single well developed fold near the base with a series of rapidly decreasing lesser folds above. Holotype; height 54 mm. (actual), 58 mm. (estimated); diameter, 39 mm."

**Synonymy—**

1952 *Euspinacassis oconnori* Dell, Dominion Mus. Records in Zoology, Wellington, vol. 1, no. 8, p. 75, figs. 4, 5 (Hurupi Creek, Palliser Bay, New Zealand. Holotype in Dom. Mus. no. M 5580).

**Phalium grangei Marwick, 1926**

(Pl. 94, figs. 5-6)

*Range*—Upper Miocene, North Taranaki, New Zealand.

*Remarks*—This species has been placed in various genera by New Zealand workers. Finlay (1926, p. 230) placed it in his *Euspinacassis* [i.e., subgenus *Echinophoria*], while Powell placed it in *Xenophalium*, and allied it to *fibratum*. The latter is the type of *Mauicassis*. Without recourse to well-preserved specimens, and



Plate 94. Figs. 1, 2, *Phalium (Echinophoria) emilyae* (Laws, 1932). Upper Oligocene, Ardgowan Shell-bed, Oamaru, New Zealand. Holotype, 55 mm. (photo courtesy of A. W. B. Powell). Figs. 3, 4, *Phalium (Echinophoria) hectori* Abbott, new name. Topotype of "*Cassis muricata* Hector", Kaipara Harbour cliffs, Auckland. Upper Eocene. 49 mm. Figs. 5, 6, *Phalium (Echinophoria) grangei* Marwick, 1926. Upper Miocene, North Taranaki, New Zealand, Holotype, 43 mm. (photo courtesy of the New Zealand Geological Survey).

relying only on the published description and figures, I am provisionally placing *grangei* in the subgenus *Echinophoria*. The original description reads:

"Shell of moderate size, suboval, inflated. Spire low, gradate to subconic, under one-third height of aperture. Spire-whorls obtusely angled, with a broad almost flat shoulder, body-whorl with slightly concave shoulder below which

it is inflated, base contracting quickly to short twisted neck bearing a conspicuous fasciole separated from constricted base by strong ridge. Sculpture: early whorls eroded, penultimate whorl with about 5 spiral threads on side and 6 on shoulder; interstices wide, each containing a secondary spiral; shoulder-angle with about 20 low blunt knobs; body-whorl with 8 cinguli, top one strongest, bottom five scarcely marked, top three with 12 to 16 rounded knobs, fourth sometimes with a few obscure ones, whole whorl with fine spiral threads. Suture strongly impressed, bordered on body by flattened cord crossed by strong oblique growth-lines. Aperture very deeply and obliquely notched below. Outer lip thickened, much reflexed. Columella somewhat damaged in all specimens but apparently with one strong grooved oblique fold at bottom of columella, above which are a number of wrinkles. Inner lip thin on the parietal wall, thickened below, fitting close to base and fasciole so that ridges of latter show through, and there is no umbilicus. Height, 43 mm.; diameter, 32 mm."

#### *Synonymy*—

- 1926 *Euspinacassis grangei* "Marwick", Finlay, Trans. and Proc. New Zealand Inst., vol. 56, p. 230, 231 (nude name).  
 1926 *Phalium grangei* Marwick, *ibid.*, p. 319 (locality 1135, Tirangi Stream, North Taranaki, Upper Miocene, New Zealand).  
 1928 *Xenophalium grangei* (Marwick), Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 636.  
 1932 *Euspinacassis grangei* Marwick, Laws, *ibid.*, vol. 62, p. 190.



Plate 95. *Phalium* (*Echinophoria*) *oneroaensis* (Powell, 1938). Lower Miocene, Waiheke Island, New Zealand. Holotype, in the Powell collection, Auckland Mus., 44 mm. (photo courtesy of A. W. B. Powell).

#### *Phalium oneroaensis* (Powell, 1938)

(Pl. 95)

*Range*—Lower Miocene, Waiheke Island, New Zealand.

*Remarks*—Powell states that this species closely resembles and appears to be directly ancestral to *toreuma* (Powell), differing only in having a shorter spire with only the uppermost row of nodules showing on the spire whorls. The original description reads:

"Shell of medium size, massive, encircled with numerous rows of strong blunt tubercles; aperture heavily variced and calloused within; canal very short, deeply notched. Apex erect, dome-shaped, of three smooth regularly-coiled whorls, nucleus minute. Spire one-fourth height of aperture. Five spiral rows of nodules on the body-whorl, only the upper most showing on the spire-whorls. Between the lowest spiral row of nodules and the fasciole are three flat-topped subsidiary spiral cords without nodules. The nodules on the uppermost spiral number eleven on the body-whorl; they are subspinose; those on the lower spirals number fourteen, and are bluntly rounded. Whole surface overlaid with fine crowded spiral lirations. Aperture narrowly ovate. Outer lip with a very heavy varix, reflexed, and bearing weak denticles along the calloused inner edge. Parietal callus thick and spreading, with irregular plait-like ridges on the pillar, and bridging across the deep umbilical chink. Height, 44 mm.; diameter, 31 mm. (holotype)."

#### *Synonymy*—

- 1938 *Euspinacassis oneroaensis* Powell, Trans. and Proc. Royal Soc. New Zealand, vol. 68, pt. 3, p. 364, 374, pl. 39, figs. 10, 11. (small bay ½ mile N.W. of Oneroa Beach, Waiheke Island, New Zealand. "Upper Oligocene").

#### *Phalium hectori* new name Abbott

(Pl. 94, figs. 3, 4)

*Range*—Lower Miocene, Pakaurangi Point, New Zealand.

*Remarks*—This species has had an unfortunate bibliographic history. It appeared several times as a *nomen nudum* and was then proposed only with a name (*muricata* Hector) and figure citation. In 1915, Suter redescribed the species in detail, partially upon an excellent drawing of the lost holotype and partially upon a paratype which now in 1964 appears also to be lost. The name, *muricata*, furthermore is a primary homonym, and I propose the new name *Phalium* (*Echinophoria*) *hectori*. Suter's re-description reads:



"Shell moderately large, ovato-ventricose, with depressed spire, appressed suture, the spire-whorls with 1, the body-whorl with 3 to 4 spinous or tuberculous keels, the whole surface finely reticulated, outer lip somewhat reflexed, lirate towards the base, inner lip forming a broad callus, lirate below. Sculpture: Spire-whorls with a distinct keel at the lower third bearing sharply pointed tubercles, developing to bluntly pointed compressed spines on the last whorl, 8 to 9 on a volution; below the uppermost keel on the body-whorl there are 3 more equally spaced rows of tubercles, diminishing in size towards the base, the lowest row having only inconspicuous tubercles; the whole surface is ornamented by close, fine spiral threads, unequal in strength, usually stronger ones have from 1 to 3 much finer ones between them; on the base the stronger threads are broader and unequal in strength; these lirae are reticulated by sinuous growth-striae; the suture is margined below by a narrow band of irregular oblique riblets. Spire low, conoidal, its height about half that of the aperture. Protoconch small, papillate, consisting of 2 convex smooth whorls. Whorls 6, first slowly descending, but the last large and ventricose; spire-whorls slightly concave at the shoulder, flat below the keel; body-whorl convex, the shoulder lightly excavated, base very little contracted. Suture appressed, margined below. Aperture subvertical, ovate, obsoletely and broadly channelled above, produced below into a distinct, short, recurved canal. Outer lip broad, thick, slightly reflexed, strongly lirate at the lower third. Columella vertical, arcuate above, straight below, inflected towards the canal. Inner lip broadly reflexed over the body, its outer edge more or less free in the adult, with an entering low plait above, and irregular oblique folds on the lower part. The siphonal fasciole strong, sharply keeled. Height, 57 mm.; diameter, 40 mm. (from drawing of the lost holotype)."

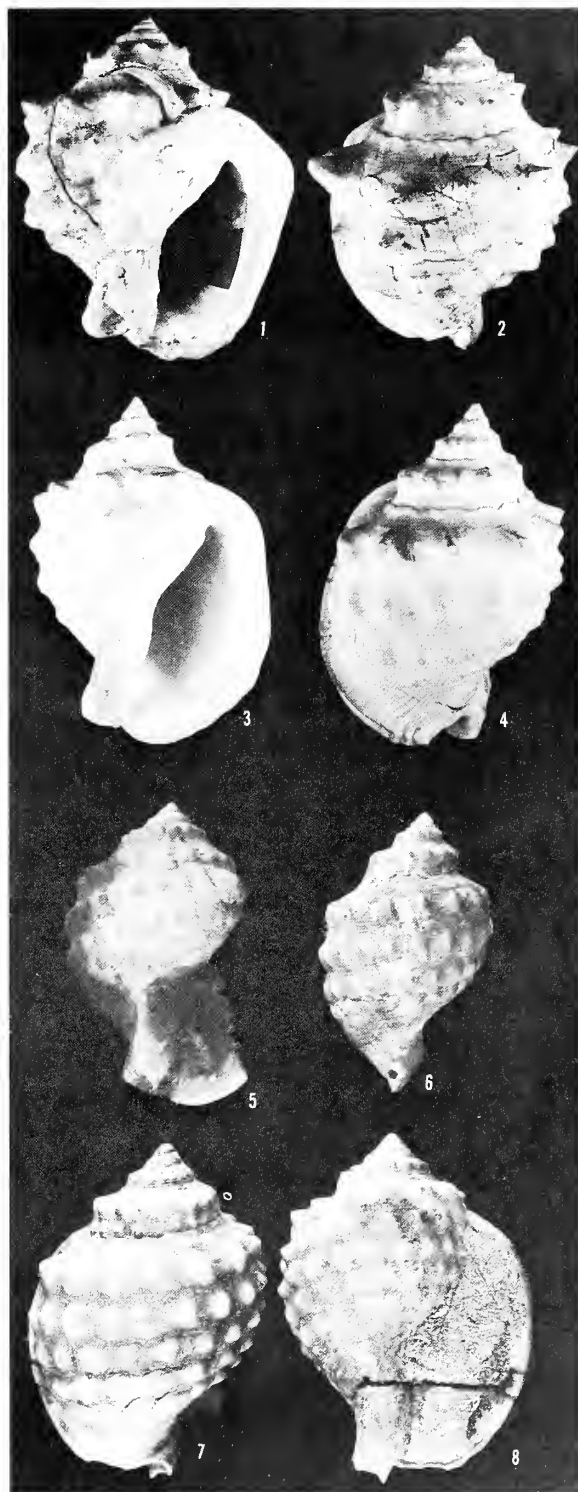


Plate 96. New Zealand fossil cassids. Figs. 1, 2, *Phalium (Echinophoria) pollens* Finlay, 1926, holotype, in Auckland Mus., Clifden, Southland; Altonian, Miocene, 69 mm. Figs. 3, 4, *Phalium emilyae* Laws, 1932, holotype, in Auckland Mus., Ardgowan shell bed, Oamaru, Awamoan, Upper Oligocene, 55 mm. Fig. 5, *Phalium (Echinophoria) multinodosum* Powell, 1928, holotype, in Auckland Mus., sea cliffs at Motutara, 30 miles west of Auckland in volcanic tuff of the Miocene, 50 mm. Fig. 6, paratype of *multinodosum*, 47 mm. Figs. 7, 8, *Phalium toreuma* (Powell, 1928), holotype, in Auckland Mus. (Powell Collection), Motutara, Miocene, 34 mm. (all courtesy of A. W. B. Powell).



*Synonymy*—

- 1877 *Cassid. muricata* Hector, Reports of Geological Explorations during 1874-6, Geol. Survey New Zealand, (ninth) Progress Report, p. v (nude name). Non *Cassid. muricata* Menke, 1828.
- 1881 *Cassid. muricata* Hector, MS, S.H.Cox, *ibid.*, for 1879-80, p. 33 (nude name).
- 1886 *Cassid. muricata* Park, *ibid.*, for 1885, p. 167 (nude name).
- 1886 *Cassid. muricata* Hector, "Detailed Catalogue and Guide to the Geological Exhibits", Indian and Colonial Exhibition in London, Wellington, p. 7, no. 59, and p. 51, fig. 9, no. 7 (Komiti, Kaipara, Auckland, Upper Eocene).
- 1915 *Galeodea muricata* (Hector), Suter, New Zealand Geol. Survey Paleont. Bull. no. 3, p. 12, pl. 1, fig. 6 (of the lost holotype). Miocene.
- 1931 *Phalium (Echinophoria) muricatum* Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 252.

***Phalium toreuma* (Powell, 1928)**

(Pl. 96, figs. 7, 8)

*Range*—Lower Miocene, Motutara, New Zealand.

*Remarks*—The shell has a close resemblance to that of the Recent deep-water Japanese *P. (Echinophoria) carnosum* Kuroda. Powell's original description reads:

"Shell rather small, strong, encircled by rows of strong rounded nodules. Outer lip rather thin, slightly recurved. Canal very short, broad, and deeply notched. Whorls  $6\frac{1}{2}$ , plus minute dome-shaped protoconch of  $2\frac{1}{2}$  smooth whorls. Penultimate whorl with two rows of nodules, the lower one just showing above suture and the upper forming a prominent shoulder just above centre of whorl. Body-whorl with 5 distinct rows of close regularly-spaced rounded nodules and three plain indistinct spiral bands below. The four lower nodulous bands close together, the upper one separated from them by a greater distance. The whole shell covered with exceedingly fine spiral striae, not showing on nodules. The shoulder bears 13 nodules on body-whorl. Spire less than half height of aperture. Suture slightly undulating. Outer lip smooth within and slightly recurved. Inner lip spreading as a callus right to shoulder. Columellar-callus rather narrow almost closing false umbilicus. Pillar bordered by a single prominent ridge running right to base of columella. Fasciole smooth, flattened, bordered above by a narrow ridge. Height, 34 mm.; diameter, 24 mm."

The feminine noun "*toreuma*" means embossed work or bas-relief.

*Synonymy*—

- 1928 *Xenophalium toreuma* Powell, Trans. and Proc. New Zealand Inst., vol. 59, pt. 3, p. 636, figs. 33, 34. (Sea Cliffs at Motutara, West Coast, 30 mi. from Auckland in volcanic tuffs, associated with *Parvamussium zitteli* Hutton. Lower Miocene?).
- 1935 *Euspinacassis toreuma* (Powell, 1928), Powell, Records Auckland Inst. Mus., vol. 1, no. 6, p. 329 (about 1.3 mi. south from Muriwai Beach, Auckland).

***Phalium multinodosum* (Powell, 1928)**

(Pl. 96, figs. 5, 6)

*Range*—Lower Miocene, Sea Cliffs at Motutara, New Zealand.

*Remarks*—This is a typical, well-nodulated *Echinophoria* closely resembling *toreuma* (Powell). The latter, from the same locality, may possibly be a young and dwarfed variant of *multinodosum* in which the parietal shield has not become fully developed. Powell's original description reads:

"Shell large, strong, encircled with rows of strong rounded nodules. Outer lip very little thickened, slightly recurved. Canal very short, deeply notched. Whorls  $6\frac{1}{2}$ , plus minute, dome-shaped, protoconch of  $2\frac{1}{2}$  smooth whorls. Spire-whorls angled at centre by a single spiral row of close regularly-spaced rounded nodules. Body-whorl with 4 rows of rounded nodules arranged axially in an oblique plane. First two rows widely spaced, last two close together. The upper row forming the shoulder has approximately 16 nodules on body-whorl as compared with 8 in *muricata*, and 11-13 in *pollens*. The whole shell is crowded with fine spiral lirae, alternating in strength. Spire a little less than half height of aperture. Suture undulating, just covering an otherwise second row of spire-nodules. Outer lip imperfect in both specimens. Inner lip spreading as a thin callus broadly over parietal wall almost to shoulder.

"Columella obliquely flexed, with heavy callus-plate almost closing false umbilical chink. Pillar with several indistinct irregular plaits. Fasciole flattened on top, longitudinally striated. Height [length] 50 mm.; minimum diam., 28 mm. (holotype).

*Synonymy*—

- 1928 *Euspinacassis multinodosa* Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 634, pl. 76, figs. 30, 31 (Sea Cliffs at Motutara, West Coast, 30 miles from Auckland in volcanic tuffs, associated with *Parvamussium zitteli* Hutton. Lower Miocene?).
- 1935, Powell, Records Auckland Inst. Mus., vol. 1, no. 6, p. 328-329.
- 1931 *Phalium (Echinophoria) multinodosum* Powell, Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 252.

**Phalium emilyae (Laws, 1932)**

(Pl. 94, figs. 1, 2; Pl. 96, figs. 3, 4)

*Range*—Lower Miocene, Ardgowan shell-bed, Oamaru, New Zealand.

*Remarks*—This species is extremely close to *P. hectori* Abbott and non-senile specimens of *P. pollens* Finlay. It is not unlike Recent deep-water *Echinophoria*. The original description reads:

"Shell fairly large, not of heavy build for its size, spire whorls with a row of tubercles at angle somewhat above middle; body-whorl with 4 rows of tubercles, those of the lowest row very weak and soon becoming obsolete towards outer lip; 11 in topmost row. Tubercles project vertically and show tendency to be laterally compressed. Whole surface covered by close spiral cords, the last six on the base (below last row of nodules) more regular and prominent and ornamented with spiral lines. Spire about half the height of the aperture. Spire whorls lightly concave both above and below the angle; a distinct concavity between tubercles in first two rows on body-whorl. Suture slightly undulating over hidden row of tubercles, appressed and margined below by a narrow swollen band. Outer lip thickened, reflexed, and carrying 8 or 9 denticles within, distinct in front, but becoming faint posteriorly. Inner lip spread as a wide and thick callus (not as thick as that of *muricata* Hector) almost completely covering nodules and reaching on to shoulder between tubercles of top row. Callus plate sunken over umbilicus, but rising anteriorly to surmount the low, rounded ridge on the fasciole. In *muricata* the callus plate is flat. Pillar with 3 or 4 small, irregular plaits below. Fasciole almost completely covered ventrally. A sharp keel behind separates it from the wide, deep groove leading to the umbilicus. In *E. muricata*, as the pillar is more erect and its base a good deal more twisted, the fasciole is relatively wider when seen laterally and the groove behind much narrower. Further, in the Pakaurangi Point species this groove widens posteriorly, whereas in the new species the channel becomes slightly narrower towards the umbilicus. Height, 55 mm.; diameter, 36 mm." [*muricata*=*hectori* Abbott].

**Synonymy—**

1932 *Euspinacassis emilyae* Laws, Trans. and Proc. New Zealand Inst., vol. 62, p. 189, pl. 28, figs. 14, 15 (Ardgowan shell-bed, Oamaru (Awamoan), New Zealand).

**Phalium pollens (Finlay, 1926)**

(Pl. 96, figs. 1, 2)

*Range*—Lower Miocene, Clifden, Southland, New Zealand.

*Remarks*—This large, sometimes heavy, species is the type of Finlay's genus *Euspinacassis*, which I consider to be a synonym of the subgenus *Echinophoria* Sacco. Some specimens, perhaps because of old age and their development in cool water, produce a thick, heavy outer lip and parietal shield. Younger specimens are very close to some Recent and some Italian Pliocene species of *Echinophoria*. The Lower Miocene *P. pollens* (Finlay), *P. hectori* (Abbott) and *emilyae* Laws are all extremely close to each other and may well be weak subspecies or forms of each other. The original description of *pollen* reads:

"Shell large, massive, encircled with rows of strong high tubercles; aperture heavily thickened, canal very short, deeply notched behind. Apex symmetrical, dome-shaped, of 3 smooth regularly-coiled whorls, nucleus minute. Four spiral rows of nodules on last whorl, only the uppermost showing on spire-whorls; 11-13 strong pointed upwardly-directed spines per whorl on top row, about 17 lower blunter nodules on second and third rows, and many weak very low nodules on lowest row; 6-8 low spiral cords on base; whole surface overlaid by very numerous close undulating spiral grooves, interstices slightly raised as weak threads. Spiral threads coarser and plainer and fenestrated by numerous thin axial threads on early spire-whorls. Spire rather high, about half height of aperture, outlines straight. Whorls medially sharply angled by nodular keel, slightly concave above and below, strongly concave between nodular rows on body-whorl. Suture strongly undulating, a little cut in. Aperture in young shells distinctly phalioid, outer lip being thickened and reflexed and bearing several denticles below, inner lip merely a thin glaze over parietal wall and pillar, but free across excavation above fasciole and forming there a small but pervious umbilicus; pillar irregularly plaited and ridged, with one stronger medial blunt ridge later forming outer margin of fasciole. Adult shell has sides of aperture enormously thickened, outer lip very strong and with thickly laminate reflexed edge; inner lip spreading as a massive parietal callus almost up to top nodular row, and as a thick free edge across umbilicus and pillar, form-

ing another umbilicus on farther side of fasciole; pillar with numerous anastomosing sharp plaits and ridges, fasciole ridge covered. Canal very short, at once bent to left and slightly backwards by a strong deep notch almost exactly as in *Phalium*. Adult shell has a second projecting varix emerging obliquely from parietal callus. Fasciole with an anterior bluntly angular ridge, bounded behind by a sharp keel, a deeply-hollowed rounded groove immediately behind it, leading into umbilicus.

"Height, 69 mm.; diameter, 55 mm. (type). Height, 39 mm.; diameter, 27 mm. (paratype). Height 27 mm.; diameter, 18.5 mm. (paratype)."

#### *Synonymy*—

- 1926 *Euspinacassis pollens* Finlay, Trans. and Proc. New Zealand Inst., vol. 56, p. 230, pl. 55, figs. 10-12 (Clifden, Southland, band 6A (Ototaran?), New Zealand, Lower Miocene).  
1931 *Phalium (Echinophoria) pollens* (Finlay), Rutsch, Eclogae Geol. Helvetiae, vol. 24, p. 252, fig. b.

#### *Phalium trinodosum* (Tate, 1889)

(Pl. 97)

*Range*—Oligocene of Victoria, Australia.

*Remarks*—I am tentatively assigning this species to the subgenus *Echinophoria* because of Tate's description and on the basis of the nature of the sculpturing on the body whorl which resembles other species in this group. The original description reads:

"Shell globosely ovate, spire short, acuminate, ending in a small conical pullus of three smooth convex whorls.

"Whorls four, excluding pullus [nucleus], con-

vex, with depressed spiral ridges and narrower sulci.

"Last whorl ventricose, contracted at the base, sculptured with flatly rounded spiral ridges, and ornamented with three rows of tubercles, one on the rounded shoulder of the whorl, the third at about half way to the front, the second about midway between. The tubercles on the posterior row are the largest, smaller in size on the medial row, and somewhat inconspicuous on the anterior row.

"Aperture lunate; outer lip very much thickened and slightly reflexed, ascending to the middle of penultimate whorl; margin smooth, except a few obscure denticles at the front; columella somewhat patulous, smooth, dentately ridged on the margin. Length, 30; breadth, 21; length of aperture, 25 mm."

#### *Synonymy*—

- 1889 *Semicassis trinodosa* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 167, pl. 7, fig. 12 (Barnsdale, Gippsland, Victoria).



Plate 97. *Phalium (Echinophoria) trinodosum* (Tate, 1889). Type of *Semicassis trinodosa* Tate, 1889, from the Oligocene of Gippsland, Victoria, Australia. Length: 30 mm.



### Subgenus *Mauicassis* Fleming, 1943

Type: *Phalium fibratum* Marshall and Murdoch, 1920

Members of this subgenus are characterized by *Tonna*-like, wide, heavy, straplike spirals, which may be nodose or slightly spinose and are continuous to the edge of the outer lip. The siphonal canal is usually bordered posteriorly by a wide deep groove. Thirteen Tertiary species may be assigned to this group, although some of them possess at least one character or another which makes their inclusion problematical. The Recent *Phalium whitworthi* Abbott from Western Australia has strap-like spirals and a deep groove behind the siphonal canal, but for reasons mentioned under its remarks I consider it a close relative of *Phalium* (*Xenophalium*) *thomsoni* (Iredale) of eastern Australia.

*Mauicassis*, with *fibratum* as its type, was proposed by Fleming in 1943. Other Miocene and Pliocene species occur in Japan and north-western United States. An extreme form, *petrosum* Conrad, was chosen as the type of *Liracassis* by E. J. Moore in 1963. It should be pointed out that the difference between a sculpture of "wide, strap-like spirals" and "a smoothish surface with deep, incised spiral lines" is only a matter of degree of the same morphological origin. These characters may be constant for some species, but should not necessarily be used as evidence of phylogenetic relationships. The presence or absence of spiral straps occur within forms of the same species, i.e. *Phalium* (*Semicassis*) *granulatum-cicatricosum* of the Recent Caribbean.

There are no living examples of *Mauicassis*, unless one wishes to conjecture, and perhaps not unjustifiably, that *Phalium wyvillei* (Watson) and other deep-water forms are direct descendants.

### Synonymy—

- 1943 *Mauicassis* Fleming, Trans. and Proc. Royal Soc. New Zealand, vol. 73, pt. 3, p. 197 (type by original designation: *Phalium fibratum* Marshall and Murdoch, 1920, Lower Pliocene, New Zealand).  
1963 *Liracassis* E. J. Moore, U.S. Geol. Survey Prof. Paper, 419, p. 30 (type by original designation: *Dolium petrosum* Conrad, 1849, Miocene, N. W. United States).

### *Phalium fibratum* Marshall and Murdoch, 1920

*Range*—Lower Pliocene of New Zealand, Waitotaran beds.

*Remarks*—This 3-inch long (75 mm.), ovate-globose, cassid has about 23 prominent strap-like spirals on the last whorl with a groove, half as wide, between them. The spiral on the upper part of the shoulder has prominent, but small, nodules. I quote the original description in full: "Shell large, ovate-globose, with prominent spiral sculpturc. Whorls about seven, lightly angular; apex minute; spire short, less than one-quarter the length of the aperture; the last very large; on the angle a rather prominent row of nodules, on the spire above the angle four or five spiral cords, and below the angle two or three, on the last about twenty-three flat spirals more than twice the width of the grooves, the latter becoming deeper on approaching the anterior end, in places there is a small groove on the rib, and here and there a small threadlet in the groove; the axials consist of strong irregular growth-striae which have a fibrous subgranular appearance. Sutures lightly impressed, the marginal rib below rather pronounced. Aperture slightly oblique and narrow above, outer lip uniformly curved, thickened and reflexed; columella short, excavate and twisted, several small denticles above and two or three oblique plaits at the anterior end; body-whorl and columella with a wide, spreading callus produced anteriorly as a broad flat plait limited to the width of the columella. Length; 75 mm.; width: 60 mm."

### Synonymy—

- 1920 *Phalium fibratum* Marshall and Murdoch, Trans. and Proc. New Zealand Inst., vol. 52 (new Issue), p. 131, pl. 8, figs. 16, 17 (Waipipi).

*Types*—The type locality is Waipipi, Waitotaran Beds, Lower Pliocene beds of New Zealand. The holotype was to have been presented to the Wanganui Museum.

### *Phalium kaawaense* (Bartrum and Powell, 1928)

(Pl. 98)

*Range*—Lower Pliocene, Kaawa Creek, west coast, New Zealand.

*Remarks*—I have not seen this species which bears two rows of low, somewhat evenly-sized nodules on the shoulder. There is a third inconspicuous row, below which are 13 strong spiral ridges. the original description reads:

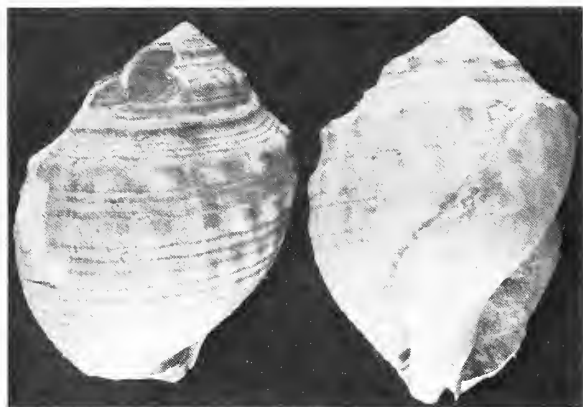


Plate 98. *Phalium (Mauicassis) kaawaense* (Powell and Bartrum, 1928), holotype, in Auckland Mus. 67 mm. (courtesy of A. W. B. Powell).

“Large inflated shell, with low conical spire, closely resembling *X. grangei* (Marwick). Earlier spiral-whorls almost flat in outline, later ones slightly convex; body-whorl slightly concave above the broadly-rounded nodular shoulder-angle, but below this, swollen above and rapidly contracting towards base. Suture bordered below by a low spiral fold with three strong spiral threads beneath on shoulder. Fasciole and outer lip broken away. Inner lip has expanded callus extending to the nodular shoulder-angle of body-whorl, thin on parietal wall but thicker below and practically closing false umbilicus. Columella callus smooth and fairly thick near base. Columella has 2 oblique folds near base, not 1 as in *grangei*. Ornamentation differs from that of *grangei* by having two strong nodular cinguli and an inconspicuous third on body-whorl, in place of three and an inconspicuous fourth, whilst intermediate sculpture is very much stronger. Spire shows only one nodular spiral as in *grangei*. Between each pair of nodular cinguli, there are two smaller similar bands separated by shallow narrow interspaces. Below the lowest, or third, nodular cingulus there are 13 similar rounded spiral ribs separated by narrow grooves. Protoconch worn. Dimensions of holotype: Height, 67 mm.; breadth, 48 mm.”

#### *Synonymy* –

1928 *Xenophalium kaawaensis* Bartrum and Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 145, figs. 53, 54 (Kaawa Creek, south of Waikato River, Tertiary of New Zealand); 1928, Powell, *ibid.*, vol. 59, p. 637, fig. 32.

### *Phalium lilliei* (Fleming, 1943)

(Pl. 99, fig. 2)

*Range* – Lower Pliocene, Waitotaran Stage, of New Zealand.

*Remarks* – This species differs from *fibratum* in having a higher spire and finer, less nodulous, spiral sculpture which does not have the beaded effect of *fibratum*. Fleming’s original description reads:

“Whorls encircled with a single row of strong rounded nodules (15-16 per whorl) and with a concave shoulder below the suture. On the shoulder, above the nodules, are five low, flat spiral threads, slightly undulating and crossed by growth lines which develop secondary threads in their shallow interspaces on later whorls; 3-4 wider and lower spiral threads traverse the nodules. Below the nodulous keel there are 1-2 broad, flat-topped spirals on earliest spire whorls, but as the suture descends steeply, five are exposed on the penultimate. On the body whorl below the keel there are 22 such spirals, frequently divided secondarily by 1-2 fine grooves in their flat summits; the interspaces, which are about half as wide as the threads, also develop secondary threads, especially on the base and below the periphery. Aperture elongate, not expanded. Outer lip thick, recurved and smooth within. Columellar callus plate thick and smooth. False umbilicus small. Four plaits on columella. Dimensions: Height, 61; diameter, 45 mm.”

#### *Synonymy* –

1943 *Xenophalium (Mauicassis) lilliei* Fleming, Trans. Royal Soc. New Zealand, vol. 73, pt. 3, p. 198, pl. 29, fig. 18 (locality 2675, Tahoraite (S.W.), S.D. Waitotaran).

### *Phalium marwicki* (Fleming, 1943)

(Pl. 99, fig. 1)

*Range* – Lower Pliocene, Waitotaran Stage, of New Zealand.

*Remarks* – This fossil cassid lacks the nodulation of other species of New Zealand *Mauicassis*, but is well marked by strong, flat-topped, spiral ridges. The original description reads:

“Sculpture: Slight indications of weak tubercles at the suture in early spire whorls, but last three whorls show only spiral sculpture of smooth, flat threads of irregular width with deep, groove-like interspaces. On the penultimate there are 23 threads, varying in width, and with inter-

spaces also varying in width and depth. On the body whorl spirals tend to be alternately wide and narrow on the base and the grooves separating them are there deepest. Elsewhere secondary threads divide the surface somewhat irregularly. Outer lip thin, unthickened, but recurved, with about 16 low denticles, strongest anteriorly, becoming obsolete behind. Columellar callus-plate thin, delimiting large false umbilicus. Dimensions: Height, 68.5; diameter, 50 mm."

#### Synonymy—

1943 *Xenophalium* (*Mauicassis*) *marwicki* Fleming, Trans. Royal Soc. New Zealand, vol. 73, pt. 3, p. 199, pl. 29, fig. 19 (locality G.S. 2499. Tahoraite (S.W.), S.D., Upper Waitotaran).

#### *Phalium onishpetensis* Otuka, 1937

(Pl. 99, fig. 8)

*Range*—Miocene of Hokkaido Id., Japan.

*Remarks*—This species is provisionally placed in the subgenus *Mauicassis*. E. J. Moore (1963, p. 31), provisionally placed it in her genus, *Liracassis*. The only known specimen is poorly preserved and is probably immature. Otuka's original description follows:

"Shell moderate in size [49.2 mm. in height;

35.7 mm. in width], globose; whorls rounded, slightly shouldered; spire moderately high; whorls sculptured with many nodulose spiral ribs and fine spiral cords. Body whorl sculptured with 13 spiral ribs, upper spiral ribs being nodulose. Nodules of the rib on the shoulder margin are most prominent (about 5 within a length of 2 cm in type specimen). On the shoulder area 3 nodulose ribs exist, nodules of which number about 5-6 within a length of 1 cm. Between these nodulose ribs on the shoulder, there are 1 or 2 fine spiral cords which are narrower than the interspaces. On the surface below the shoulder are more or less smooth spiral ribs which interspaces are sculptured with about 4 fine unequal spiral cords. Suture collared. Sub-sutural area grooved, columellar *Doliocassis* [*Mauicassis*] type."

#### Synonymy—

1937 *Phalium* (*Doliocassis*) *onishpetensis* Otuka, Japanese Jour. Geol. and Geography, vol. 14, art. 13, p. 170, pl. 16, fig. 4 (upper course of the Toyomakubetu River, Soya-mura, Hokkaido Id., Japan).

1963 ?*Liracassis onishpetensis* Otuka, E. J. Moore, U. S. Geol. Survey Prof. Paper, 419, p. 31 (Onishpets formation, Miocene, Japan).

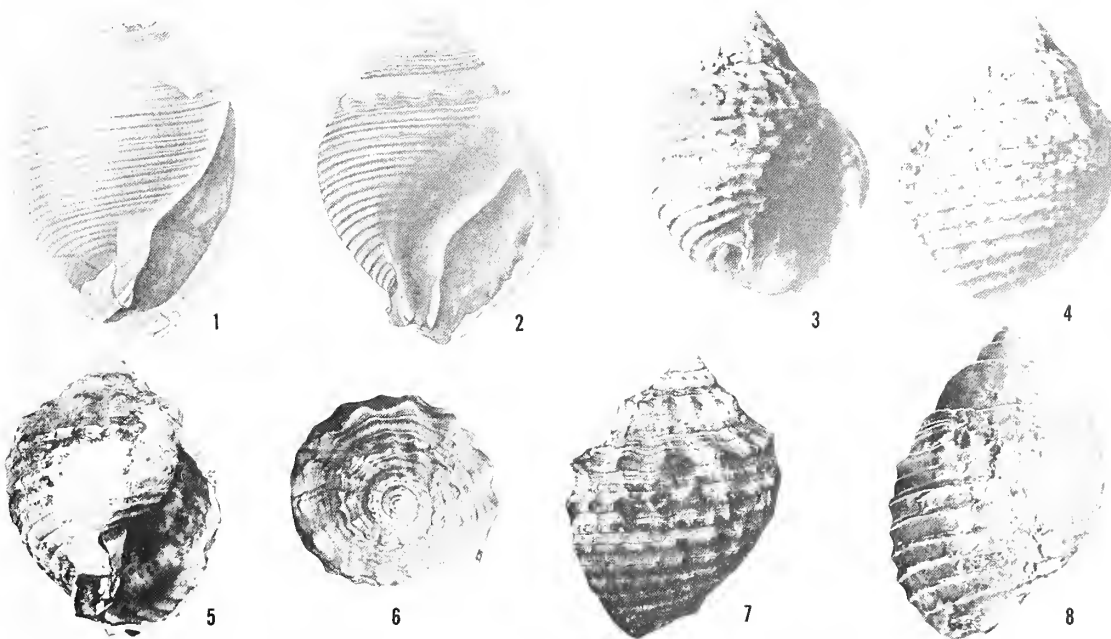


Plate 99. Members of the subgenus *Mauicassis*. Fig. 1, *Phalium* (*Mauicassis*) *marwicki* (Fleming, 1943). Tertiary, Upper Waitotaran; Dannevirke, New Zealand. Holotype. 68.5 mm. Fig. 2, *P. (M.) jilliei* (Fleming, 1943). Tertiary, Upper Waitotaran; Dannevirke, New Zealand. Holotype. 61 mm. (both from Fleming, 1943). Figs. 3, 4, *P. (M.) yokoyamai*

Nomura and Hatai, 1933 (holotype of *Galeodea japonica* Yokoyama, 1923). 60 mm. Figs. 5-7, *P. (M.) yokoyamai* Nomura and Hatai, 1933. Miocene, Susahara Formation, Toyama-Ken, Japan, 47 mm. Fig. 8, *P. (M.) onishpetensis* Otuka, 1937. Tertiary of Hokkaido, Japan. Holotype. 49.2 mm.



***Phalium yokoyamai* Nomura and Hatai, 1933**

(Pl. 99, figs. 3, 4)

*Range*—Lower Pliocene, Japan.

*Remarks*—I have not seen this or the following species which seem very similar to each other. Nomura and Hatai have given a rather detailed account of both (1933, p. 50-53). Yokoyama's original description is as follows:

"Shell solid, oval, ventricose. Whorls about seven with the body-whorl more than three times as long as the spire; convex, spirally as well as longitudinally sculptured. Spiral sculpture; consists of more or less flat cords, five on the penultimate and twelve on the ultimate whorl, the uppermost on the former is close to the upper suture, while the lowest is very near the lower, the interspaces between the cords being in the upper part broader than the cords themselves, but gradually decreasing in breadth; on the body whorl the two uppermost interspaces are not only broader than the others, but also several times broader than the cords and furnished with a few spiral striae on the surface; the remaining interspaces are subequal in breadth, but always a little broader than the cords. Longitudinal sculpture; consists of distant threads, eighteen on the penultimate and twenty on the ultimate whorl, which on crossing the cords become tubercular with tubercles most distinct on the three upper whorls. On the whorls above the penultimate, the sculptures, spiral as well as longitudinal, are not very distinct. Outer lip strongly varicose without and coarsely dentate within, the teeth corresponding in position to the cords outside. Aperture acute behind, fractured in front. Height 60 mm. Diameter 35 mm."

*Synonymy*—

- 1923 *Galeodea (Sconsia) japonica* Yokoyama, Japanese Jour. Geol. and Geography, vol. 2, no. 1, p. 3, pl. 1, figs. 4. (Kagami Neogene of Izuma, Japan); 1923, Yokoyama, Jour. College Sci. Imperial Univ. of Tokyo, vol. 65, art. 2, p. 11 (Lower Pliocene of Izumo); 1923, Yokoyama, *ibid.*, vol. 65, art. 5, p. 11, pl. 1, fig. 10 (Izura; Yunami. Pliocene of Izuma); 1926, Yokoyama, Jour. Faculty of Sci. Imperial Univ. Tokyo, section 2, vol. 1, pt. 7, p. 240 and pt. 9, p. 342 (Satsuka Beds; Dainichi).
- 1927 *Tonna japonica* (Yokoyama), Makiyama, Memoirs College Sci. Kyoto Imperial Univ., series B, vol. 3, no. 1, p. 73 (Tertiary of Nara). Not *Tonna japonica* (Dunker, 1867).
- 1933 *Phalium yokoyamai* Nomura and Hatai, Japanese Jour. Geol. and Geography, vol. 11, p. 50, pl. 8, figs. 1, 1a, 3, 7. New name for *Phalium japonicum* Yokoyama, 1923, non *Phalium japonicum* (Reeve, 1848)=*bisulcatum* Schubert and Wagner, 1829.

1937 *Phalium (Doliocassis) yokoyamai* Nomura and Hatai, Otuka, *ibid.*, vol. 14, p. 170.

1949 *Shichiheia yokoyamai* Nomura and Hatai, Hatai and Nisiyama, Jour. of Paleontology, vol. 23, no. 1, pp. 93, 94.

1963 *Liracassis yokoyamai* Nomura and Hatai, E. J. Moore, U. S. Geol. Survey Prof. Paper, no. 419, p. 30 (Fujina and Sugota formations, Miocene, Japan).

*Nomenclature*—As long as this species is assigned to the genus *Phalium*, the name *yokoyamai* Nomura and Hatai may be used, but should *Semicassis*, *Liracassis* or *Maucassis* be used as a full genus, the name *japonica* Yokoyama, 1923, will have to be re-instated, since *Cassis japonica* Reeve, 1848, does not preoccupy *Galeodea japonica* Yokoyama while they are currently in different genera.

*Records*—(all from Nomura and Hatai, 1933, p. 52). Lower Pliocene of Japan: Higashi-Kimachi, Kimachi-mura, Yatsukagun, Prov. of Izumo; Otsu, Hirakata-mura, Taga-gun, Prov. of Hitachi, Honshu; the Tokiwa Series; Tennoyama, near Kakegawa, Prov. of Totomi, lower Kakegawa Series; Tsurushi-hama near Sukegawa, Prov. of Hitachi, Shirado Beds; oil fields of Embets, Beds A and C, Teship-gun, Prov. of Teshio, Hokkaido.

***Phalium yabei* Nomura and Hatai, 1933**

*Range*—Pliocene and Miocene of Honshu, Id., Japan.

*Remarks*—This species and *yokoyamai* are evidently very close to *Phalium iani* Schenck, 1926, from the Miocene of Washington State. The original description follows:

"Shell of moderate size, oval, with about seven rounded whorls separated by a distinct, appressed, but not channeled suture; body whorl nearly three times as long as the spire; apex rather acute, the surface generally is spirally as well as longitudinally sculptured; spiral sculpture consisting of strong, somewhat flattened cords regularly spaced and separated by nearly equal, channeled interspaces, twelve on the body whorl, and five on the penultimate whorl, generally provided with one or two interstitial threads between the cords, except the few basal ones; the striae on the upper part of the body whorls being stronger than the lower ones; axial sculpture consists of several threads extending from suture to suture and becoming obsolete on the base of the body whorl; on crossing the axial and spiral cords they become distinct tubercles or nodules; tubercles becoming obsolete towards the base. Outer lip thickened, reflected and coarsely dentate within; inner lip with thin callosity, smooth above, plicate below. Canal short, rather wide, slightly recurved. Aperture rather

small, acute behind and obtuse in front; pillar (?) short. One of the specimens measures 47 mm. in height and 35 mm. in diameter."

### Synonymy—

- 1933 *Phalium yabei* Nomura and Hatai, Japanese Jour. Geol. and Geography, vol. 11, p. 52, pl. 8, figs. 2, 4, 5, 6, 8, 8a (type locality here selected: Yawata, Tomino-mura, Date-gun, Prov. of Iwaki; Yanagawa Beds, Beds of Tsujita; Reg. No. 38601).
- 1940 *Phalium (Doliocassis) yabei* Nomura and Hatai, Nomura, Tohoku Imperial Univ. Sci. Reports series 2, Geology, vol. 21, no. 1, p. 39 (Kita-Akai, Moniwa Shell Beds, Sendai, Japan; Miocene).
- 1949 *Shichiheia yabei* Nomura and Hatai, Hatai and Nisiyama, Jour. of Paleontology, vol. 23, no. 1, p. 93.
- 1963 *Liracassis yabei* Nomura and Hatai, E. J. Moore, U.S. Geol. Survey Prof. Paper, 419, p. 30 (Yanagawa formation, Miocene and Sueno-matsuyama formation, Pliocene, Japan).

*Records*—See under synonymy.

### *Phalium petrosum* (Conrad, 1849)

*Range*—Miocene, Astoria formation of northwest United States.

*Remarks*—*Phalium petrosum* (Conrad) is characterized by having strong subrounded straplike spiral cords on the body whorl beneath the shoulder. The spiral cord at the shoulder is produced into about 17 nodes which continue as ridges to the suture. The cords on the spire are smaller than those on the body whorl but are also produced into nodes at the shoulder, with a faint trace of a ridge continuing from the nodes to the suture. At least 10 cords are present below the shoulder of the body whorl and 3 below the shoulder of the spire. There are fine spiral threads between the cords on the body whorl; the median of these threads may be more strongly developed than the others. (from E. J. Moore, 1963, p. 31).

The species is variable, and a rare *forma* was named *biliratum* (Conrad, 1865) in which the nodes on the shoulder of the body whorl are more produced and spinelike, in which there are subdued nodes on the spiral cord at the base of the angulation below the shoulder, a more concave shoulder without the strong ridgelike continuations of the nodes to the suture, and finer spiral cords on the shoulder.

A full account of this species was given by E. J. Moore (1963, pp. 30, 31). She points out that Reagan (1909, pl. 3, fig. 32), Dall (1909, pl. 14, fig. 6) and Tegland (1931, pl. 65, figs. 6, 7) figured but mis-identified this species as *apta* Tegland, 1931.

*Synonymy*—(also see E. J. Moore, 1963, p. 31).

- 1849 *Dolium petrosum* Conrad, U. S. Explor. Exped., Geology, vol. 10, appendix p. 727, atlas pl. 19, figs. 3-5 (Astoria, Oregon); 1963, E. J. Moore, U. S. Geol. Survey Prof. Paper, 419, p. 31, pls. 2, 4 and 10 (lecto-type, USNM no. 561550, selected and figured).
- 1865 *Doliopsis biliratum* Conrad, Amer. Jour. Conchology, Philadelphia, vol. 1, p. 150 (refers to his 1849, pl. 19, figs. 4a, 4b).
- 1963 *Liracassis petrosa* (Conrad), E. J. Moore, *loc. cit.*, pp. 30, 31, pls. 2, 4 and 10.

### *Phalium fax* (Tegland, 1931)

*Range*—Oligocene, Lincoln formation, northwest United States.

*Remarks*—While placed in *Liracassis* [i.e. *Manicassis*] by Moore (1962), this species could also be placed in the subgenus *Echinophoria*, as was done by Durham (1942). The shell is well-figured by Tegland and by Durham, and I am not repeating Tegland's lengthy, original description. Durham distinguishes it from other Oligocene species in stating the "spiral ribs not cord-like except anteriorly on body whorl, body whorl strongly carinated by three rows of nodes, shoulder above first row of nodes strongly concave, suture appressed, spirals above shoulder of even size, 7 to 8 in number."

Weaver states that this species is common in the middle Oligocene of Oregon and Washington.

### *Synonymy*—

- 1931 *Galeodea fax* Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, p. 412, pl. 59, figs. 4, 5. (Porter shale, Lincoln horizon, Oligocene, Chehalis Co., Washington); 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 406, pl. 79, figs. 9-11.
- 1942 *Echinophoria fax* (Tegland), Durham, Jour. of Paleontology, vol. 16, p. 185, pl. 30, fig. 4. (holotype refigured).
- 1963 *Liracassis fax* (Tegland), E. J. Moore, U.S. Geol. Survey Prof. Paper, 419, p. 30.

### *Phalium rex* (Tegland, 1931)

(Pl. 100)

*Range*—Upper Oligocene, Blakely formation, Puget Sound Basin and north side of Olympic Peninsula, Washington State.

*Remarks*—This species could be placed either in the subgenus *Manicassis* or *Echinophoria*. It is characterized by its large size, strong tabulation, prominent, relatively broad, flat-topped spiral ribs without secondary ribs in the interspaces, and strong compressed nodes.

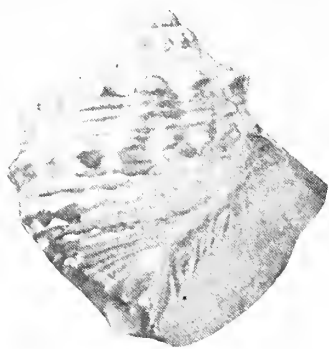


Plate 100. *Phalium (Mauicassis) rex* (Tegland, 1931). Holotype of *Galeodea rex* Tegland. Upper Oligocene, Seattle, Washington. Length: 70 mm. (from Durham, 1944, pl. 18, fig. 10).

*Synonymy*—

- 1913 *Eudolium petrosus* (Conrad), Arnold and Hannibal, Proc. Amer. Philos. Soc., vol. 52, p. 583; 1916, Weaver, Univ. Wash. Publ. Geol., vol. 1, pp. 6, 30; 1917, Dickerson, Proc. Calif. Acad. Sci., series 4, vol. 7, p. 163; 1918, Van Winkle, Univ. Wash. Publ. Geol., vol. 1, no. 2, p. 76.
- 1931 *Galeodea rex* Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, pp. 413-416, pl. 60, fig. 12, pl. 61, figs. 1-4, pl. 62, figs. 1-6 (Restoration Point, Kitsap Co., Seattle, Wash., Upper Oligocene); 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 407, pl. 80, figs. 2, 4, 6.
- 1942 *Echinophoria rex* (Tegland), Durham, Jour. of Paleontology, vol. 16, p. 185, pl. 30, figs. 1-3. (holotype re-figured).
- 1963 *Liracassis rex* (Tegland), E. J. Moore, U. S. Geol. Surv. Prof. Paper, 419, p. 30 (late Oligocene or early Miocene, Washington and Oregon).

*Phalium apta* (Tegland, 1931)

(Pl. 101)

*Range*—Upper Oligocene, Blakeley formation, Clallam Co., Washington State.

*Remarks*—When one examines the specimens and figures of *P. apta* and *rex*, both from the Blakeley formation, one wonders how much variation should be allowed for these “paleontologists’ species.” Weaver’s 1942 figures of *apta* (pl. 80, fig. 5) and *rex* (pl. 30, fig. 6) leave little room for valid differentiation. It must be that variation within a species did not enter the evolutionary scheme until Recent times, otherwise the paleontologists could not justify their manufacture of numerous genera and species. It is convenient, and practical, to have index species, but this concept can continue only while relatively few specimens and locality records are available. Further field work will doubtlessly produce the intergrades or perhaps even more “species” and “genera”. The differences carefully illustrated and described are actually those existing between specimens, not species.



Plate 101. *Phalium (Mauicassis) apta* (Tegland, 1931). Holotype (left) and paratype (right) of *Galeodea apta* Tegland. Upper Oligocene, Clallam Co., Washington. Length: 55 mm. (from Durham, 1944, pl. 18, figs. 13, 15).

As Weaver states, “this important upper Oligocene species differs from *G. rex* Tegland in being relatively smaller [but his figure 5 of *apta* is larger than his figure 6 of *rex*, both  $\times 1$ ] and less tabulate [not according to figs. 3 and 5 of *apta* as compared with figs. 4 and 6 of *rex*!] with somewhat rounded shoulders [fig. 3 of *apta* has less rounded shoulders than *rex*, fig. 6]. Other comparisons by Weaver concerning narrowness of ribs, size of interspaces and number and size of nodes are equally uninformative and unjustified.

*Synonymy*—

- 1909 *Eudolium petrosus* Conrad, Dall, U. S. Geol. Surv. Prof. Paper, 59, p. 71, pl. 14, fig. 6.
- 1931 *Galeodea apta* Tegland, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 19, pp. 415-417, pl. 63, fig. 1-10 (In sea cliff one-half mile west of Twin Rivers, Clallam Co., Washington); Weaver, 1942, Univ. Wash. Publ. Geol., vol. 5, p. 408, pl. 79, figs. 12, 13, pl. 80, figs. 1, 3, 5.
- 1942 *Trachydolium dalli* Howe, Weaver, loc. cit., p. 408 (in synonymy of *apta*).
- 1942 *Echinophoria apta* (Tegland), Durham, Jour. of Paleontology, vol. 16, pp. 185, 190, pl. 30, figs. 6-8.
- 1963 *Liracassis apta* (Tegland), E. J. Moore, U. S. Geol. Surv. Prof. Paper, 419, p. 30.

*Phalium tegalensis* (K. Martin, 1899)

*Range*—Pliocene of Pangka, Java, Indonesia.

*Remarks*—The sole immature specimen is so poorly preserved that I only provisionally assign *tegalensis* to the subgenus *Mauicassis*. Martin likened it to the Recent *P. (Semicassis) granulatum*, but the noded cords are too distantly spaced, and the contours of the whorls too globose to justify this relationship.

*Synonymy*—

- 1899 *Cassis (Semicassis) tegalensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 1, pt. 1, p. 156, pl. 24, figs. 363, 363a, 363b (Pangka, District Gantungan, Tegal, Java; Pliocene).



### Subgenus *Galeodosconsia* Sacco, 1890

Type: *Phalium striatulum* Bell. and Mich., 1841

During the Eocene and Oligocene of Europe and North America there existed a number of cassids which combined the characters of typical *Sconsia*, *Phalinm*, and *Galeodea*. The subgenus *Galeodosconsia* was erected by Sacco for this "intergrading" group. The nucleus of the shell is that of a *Phalinm*. The siphonal fasciole is poorly produced, and in most species there is a very weak channel posterior to it. In most species the outer lip is curled and thickened inwardly, rather than outwardly. This causes former varices to protrude on the inside of the shell.

#### Synonymy—

- 1890 *Galeodea* (subgenus *Galeodosconsia*) Sacco, I Molluschi dei Terreni Terziarii del Piemonte e della Liguria, pt. 7, p. 69. Type by original designation: *Cassidaria striatula* Bon. = *Cassis striatula* Bellardi and Michelotti, 1841; also by Cossmann's subsequent 1903, p. 133 designation.
- 1909 *Phalium* (*Doliocassis*) Dall, U. S. Geol. Survey, Professional Paper no. 59, p. 62. Type by original designation: *Buccinum sowerbyi* Lea = *Cassis nupera* Conrad, 1833. Eocene.
- 1928 *Sconsia* (*Galeodosconsia* Sacco), Woodring, Carnegie Institution of Washington, Publ. no. 385, p. 308.

We are placing the following species in *Phalinm*'s subgenus *Galeodosconsia* with some reservations. Wrigley (1934) and others have at times listed these species as "*Cassis*".

#### European

*Cassis striatula* "Bonelli" Bellardi and Michelotti, 1841, Memorie Reale Accademia Scienze Torino, ser. 2, vol. 3, p. 143, pl. 4, fig. 7, 8 (Torino; Miocene of Italy); Sacco, 1890, I Molluschi Terreni Terziarii Piemonte Liguria, pt. 6, p. 69, 70 with variety *ottnangiensis* Sacco and its subvariety *elegans* Sacco and variety *subottnangiensis* Sacco, pl. 2, figs. 27, a, b (Elveziano, Colli torinesi); Hoernes and Auinger, 1879, Abhandlungen der K. K. Geologischen Reichsanstalt, Vienna, vol. 12, pt. 1, p. 162, pl. 17, fig. 14 (Ottang, Austria; Miocene).

*Cassis calantica* Deshayes, 1835, Description Coquilles Fossiles des Environs de Paris, vol. 2, p. 640, pl. 85, figs. 17-19 (Valmondois, Paris

Basin); 1911 Cossmann and Pissarro, Iconographie Coquilles Eocene Paris, vol. 2, pl. 33, fig. 165-4, pl. 34, fig. 165-4 as *calantica* [sic]; Wrigley, 1934, Proc. Malacol. Soc. London, vol. 21, no. 2, p. 118, fig. 20 (Auversian, Upper Bracklesham Beds of Huntingbridge, England; Lower Oligocene of Belgium and north Germany). *C. quenstedti* is a synonym.

*Cassis quenstedti* Beyrich, 1854, Zeit. deutsch. Geol. ges., vol. 6, p. 470, pl. 10, fig. 2a, b (is *calantica* Deshayes, fide Wrigley, 1934, p. 118).

*Cassis striata* J. Sowerby, 1812, Mineral Conchology of Great Britain, vol. 1, p. 24, pl. 6 (lower 4 figs.). Not *Cassis striatus* de Serres, 1829, nor *Cassidaria striata* Lamarck, 1816. See Wrigley, 1934, p. 116, who says synonyms are *Cassidaria ambigua* J. de C. Sowerby, 1850, and *spinosa* Newton, 1891 (nude name and non Deshayes, 1844).

*Cassidaria ambigua* J. de C. Sowerby in Dixon, 1850, Geology. . . of Sussex, ed. 1, pl. 15, fig. 9. Non Solander, 1766, which is a *Sconsia*. Is a synonym of *Galeodosconsia striata* J. Sowerby, 1812.

*Cassis germari* Philippi, 1847, Palaeontographica, vol. 1, no. 2, Mar. 1847, p. 75, pl. 10, fig. 13 (1845 name is nude). Is synonym of *striata* J. Sowerby, 1812, fide Glibert, 1963, p. 109. Lower Oligocene.

*Cassis germari* var. *lima* von Koenen, 1889, Abhandl. zur Geologischen Specialkarte Preussen Thuringischen Staaten, Berlin, vol. 10, pt. 1, p. 250, pl. 22, fig. 6 (Grimmerten, Germany; Lower Oligocene). Is probably *striata* Sowerby.

"*Cassis*" *angustana* Wrigley, 1934, Proc. Malacological Society London, vol. 21, no. 2, p. 118, fig. 21 (London Clay, Highgate; Eocene). Near *striata* J. Sowerby, 1812.

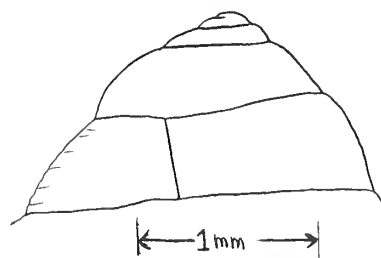


Plate 102. Nuclear whorls of *Phalium* (*Galeodosconsia*) *nupera* (Conrad, 1833). Eocene of southeastern United States.

## North American

*Cassis brevicostatus* Conrad, 1834, Jour. Acad. Nat. Sci. Philadelphia, vol. 7, p. 146 (Claiborne, Alabama; Eocene); for complete treatment, see Palmer, 1937, Bull. Amer. Paleontology,

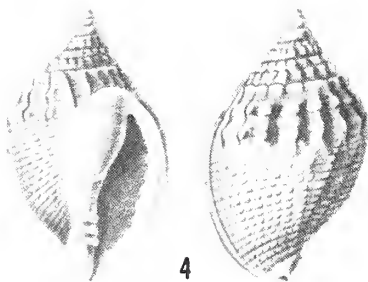
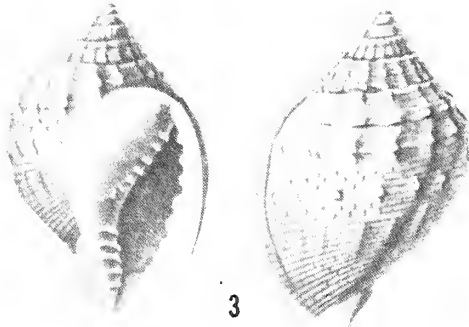


Plate 103. European members of *Phalium* (*Galeodosconsia*). Fig. 1, type of the subgenus, *P. (G.) striatulum* (Bellardi and Michelotti, 1841). Miocene of Europe. 27 mm. (from Hoernes and Auinger, 1884, pl. 14, fig. 14). Fig. 2, *P. (G.) calantica* (Deshayes, 1835). Eocene of the Paris Basin. 32 mm. (from Cossmann and Pissarro, 1911, pl. 34, fig. 165-4). Fig. 3, *P. (G.) striatum* Sowerby, 1812. Tertiary of northern Germany. 29 mm. (from Beyrich, 1854, pl. 10, figs. 1a, b). Fig. 4, *P. (G.) type of Cassis quenstedtii* Beyrich. 26.5 mm. (from Beyrich, 1854, pl. 10, figs. 2a, b).

vol. 7, no. 32, p. 248, pl. 31, figs. 4, 9-11, pl. 83, fig. 9. *Cassis globosum* Dall, 1890, is a synonym.

*Phalium brevicostatum creolum* Palmer, 1947, Bull. Amer. Paleontology, Ithaca, vol. 30, no. 117(sec. 2), p. 328, pl. 42, figs. 7, 8 (Moody's Branch marl, locality 10, Montgomery, Louisiana; Eocene).

*Cassis (Phalium) globosum* Dall, 1890, Trans. Wagner Free Inst. Science, Philadelphia, vol. 3, pt. 1, p. 161 (Upper Eocene of Mississippi, near Newton; and Ocala, Florida); 1892, *ibid.*, pt. 2, p. 262, pl. 20, figs. 6, 11. See Palmer, 1937, p. 248, is *brevicostatus* Conrad, 1834.

*Cassis hodgii* Conrad, 1841, American Journal Science, vol. 41, p. 346, pl. 2, fig. 10. Natural Well, Duplin Miocene of North Carolina. The type in A.N.S.P. no. 18860 is 29.2 mm. in length. It appears to be closer to *Galeodosconsia* than *Sconsia*. Also spelled *hodgei* by authors.

*Buccinum sowerbii* Lea, 1833, Contributions to Geology, Philadelphia, p. 164, pl. 5, fig. 169. Is a synonym of *Phalium (Galeodosconsia) nuperum* (Conrad). For details, see Palmer, 1937, Bull. 7, American Paleontology, no. 32, p. 253, pls. 31 and 83. Eocene of Alabama.

*Cassis nuperus* Conrad, 1833, Fossil Shells Tertiary Formations of North America, Philadelphia, vol. 1, no. 4, p. 46. For a complete synonymy, see Palmer, 1937, Bull. 7, American Paleontology, no. 32, p. 253, pl. 31 and 83. Eocene of Alabama.

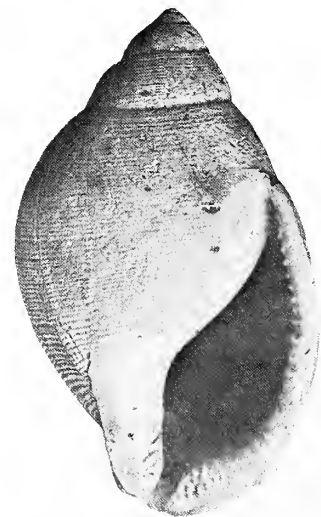


Plate 104. *Phalium (Galeodosconsia) hodgii* (Conrad, 1841). Miocene of North Carolina. 68 mm. (from Cossmann, 1903, pl. 6, fig. 3).

### Subgenus *Semicassis* Mörch, 1852

Type: *Phalium bisulcatum* Schubert and Wagner, 1829

The shells in this subgenus are somewhat globular, rarely with former varices in the spire, usually with numerous spiral threads or incised lines on the outside, usually with rows of squarish, yellowish spots, with a wrinkled columellar shield, and a finely denticulated, thickened outer lip. The base of the outer lip lacks terminal spines, and the longitudinally threaded siphonal fasciole lacks the single, raised ridge found in *Echinophoria*. The operculum is fan-shaped and may be smoothish or strongly sculptured radially.

The subgenus *Tylocassis* Woodring differs only in having numerous small pustules on the columellar shield. *Phalium bandatum* subspecies *exaratum* Reeve serves as a morphological intermediate between *Phalium s.s.* and *Semicassis*.

The egg mass of *Phalium (Tylocassis) granulatatum* (Born) from the Caribbean is illustrated on the first page of this monograph.

Dall (1909, p. 62) and Schenck (1926, p. 77) erroneously used the name *Bezoardica* Schumacher, 1817, for this subgenus, but Iredale (1927, p. 334) showed that this name is synonymous with *Phalium* Link, 1807. Iredale (1927, p. 334) considered *Echinophoria* Sacco, 1890, to be a synonym of *Semicassis* Mörch, but I believe it to be different.

### Synonymy—

- 1852 *Semicassis* Mörch, *Catalogus Conchyliorum*. . . Yoldi, Copenhagen, p. 112. Type by subsequent designation by G. F. Harris, 1897, p. 198: *S. japonica* Reeve [which is *bisulcatum* Schubert and Wagner]. Cossmann, 1903, p. 125 unnecessarily designated *Buccinum saburon* L. [Brug.]
- 1888 *Faurotis* Jousseaume, *Mem. Soc. Zool. France*, vol. 1, p. 188. Type by original designation: *F. faurotis* Jousseaume, 1888.
- 1927 *Antephalium* Iredale, *Records Australian Museum*, Sydney, vol. 15, p. 350. Type by original designation: *Cassid. semigranosa* Lamarck, 1822.
- 1928 *Kalua* Marwick (subgenus of *Phalium*) *Trans. and Proc. New Zealand Inst.*, vol. 58, p. 482. Type by original designation: *P. (K.) skinneri* Marwick, 1928.

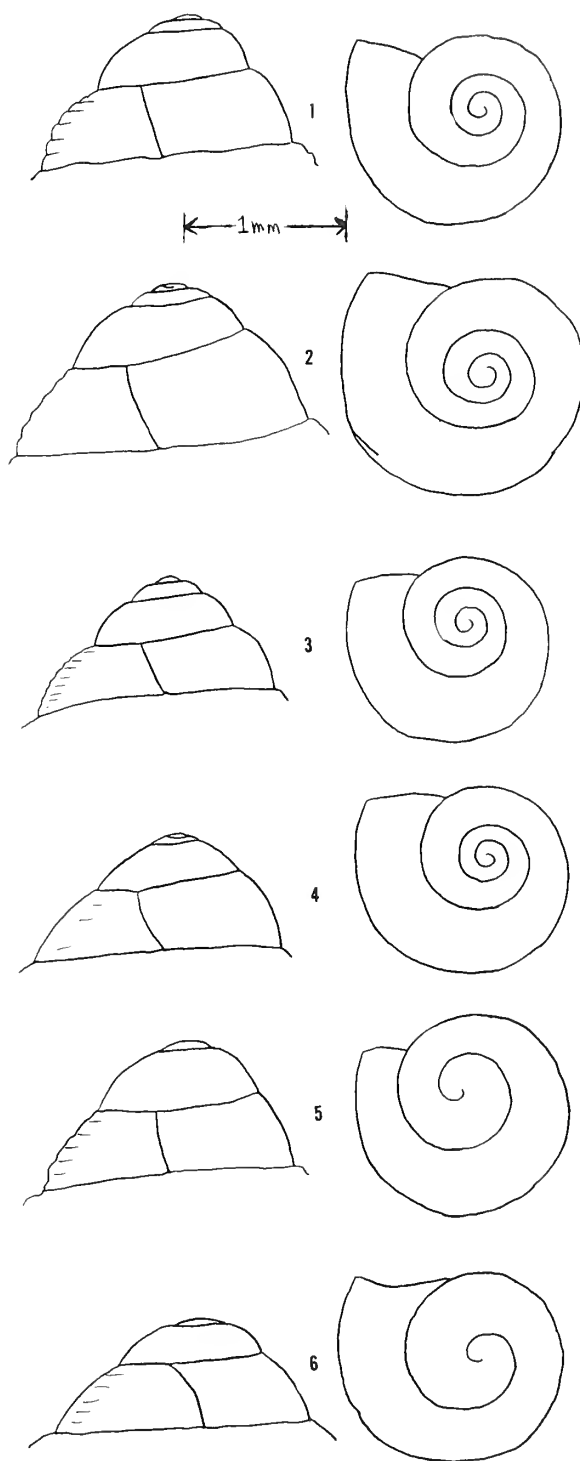


Plate 105. Nuclear whorls of *Phalium* (*Semicassis* and *Xenophalium*). Fig. 1, (*S.*) *bisulcatum* (Schubert and Wagner). Fig. 2, (*S.*) *granulatatum* (Born). Fig. 3, (*X.*) *pyrum* (Lamarck). Fig. 4, (*X.*) *labiatum* (Perry). Fig. 5, (*X.*) *semigranulosum* (Lamarck). Fig. 6, (*X.*) *sinuosum* (Verco).



***Phalium bisulcatum*  
(Schubert and Wagner, 1829)**

(Pl. 8, figs. 13-21; pls. 105-114)

*Rauge*—East Africa to the Marshall Islands and Japan to Australia.

*Remarks*—This widely distributed Recent species, known from eastern Asia and the East Indies during the Upper Miocene, Pliocene and Pleistocene, exhibits a remarkable array of forms, both in color and sculpture, which are difficult to ascribe to either genetic or ecological causes. Each colony appears to be unique in shell characters. Some forms, such as forma *diuturnum* Iredale, occur commonly in distantly located areas, such as in Australia, North Borneo and Japan, but are absent or perhaps very rare in the intervening areas. The only generalization I can draw is that larger forms exist in cooler waters, that more coarsely sculptured specimens occur in deeper waters where the bottom is muddy, and that smaller, more brightly spotted specimens occur in tropical areas where the water is shallow and the bottom is of coral sand. Many of these forms have received names.

More than one varix is seldom formed in this species, except in heavy, strongly lirate specimens from 50 to 100 fathoms in the Philippines, from 23 fathoms off Madagascar, from 20 fathoms in southern China (Hong Kong), the Bay of Bengal, and in some Japanese specimens. This was given the name *pfeifferi* Hidalgo, 1871, and "var, *minor*" Küster, 1857. This character may be associated with cool water. Some shells may bear a total of 6 varices.

The size, shape and color density of the squarish, reddish spots on the shell are very variable. The spots tend to be weak or obsolete in many localities, and in conjunction with closely packed, flattened spiral ridges, constitute what I refer

to as forma *diuturnum* Iredale which is prevalent in Australia, Malaya and Japan. The whole shell commonly has a grayish or bluish cast. Specimens of this form found along northern Australia are smaller, but not necessarily of a "narrower build" as stated by Iredale (1927, p. 335). The number of spiral ridges or lirae on the body whorl varies from 29 to 40 in Queensland shells, 29 to 49 in Hong Kong and 22 to 38 in Northern Territory, Australia, with no correlation with the degree of spotting, size of shell, occurrence of former varices, depth of water or geographical distribution. I find similar evidently uncorrelated variation in the degree of wrinkling on the columellar shield, globosity of the shell, thickness of the last varix, and the number of dentitions on the outer lip. Axial sculpture, causing a reticulation on the surface of the spire, appears in specimens which come from muddy bottoms at depths over 20 fathoms.

If these various combinations of forms were accepted and named as species, it would necessitate the description of several hundred new species. Considering the known existence of intergrades, the probable effect of environment, and the degree of speciation existing in other cassids from the Indo-Pacific and other parts of the world, I would think such a course of little taxonomic value.

Unfortunately, Schubert and Wagner's *bisulcatum* is based upon a rather uncommon form which is well-spotted and smooth on the last whorl, except for 2 or 3 rather strong cords below the suture which cause the shoulder to be tabulate. I have seen this form, whose shell varies from 30 to 50 mm. in length, from the Philippines, Dutch New Guinea, Andamans (*booleyi* Sowerby, 1900), and Madagascar. This form is so dominant and is so further modified in eastern Australia, that I have recognized it as



Plate 106. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Variations in size, sculpture, shape and color

pattern in specimens from Maqueda Bay, Samar Island, Philippines. All natural size.

the geographical subspecies *sophia* Brazier, 1872.

E. J. Kuenzler (*in litt.* 1963) states that the only other organism taken in the bottom haul at the Eniwetok lagoon, Marshall Islands, was the echinoid "sea mouse", *Rhinobrissus heuisteroides* A. Agassiz, 1879. This may be the food of *P. bisulcatum*.

**Description**—Shell 23 to 71 mm. (about 1 to 3 inches) in length, ovate-globose, smooth or spirally striate, thin- or thick-shelled, with or without 5 or 6 spiral rows of reddish to yellowish brown, squarish spots, and with a rugose or spirally lirate columellar shield. A very variable species. Nuclear whorls 3 to 3½, bulimoid, slightly tilted, smooth, glossy, white or tan. Early postnuclear whorls with 4 to 7 small, beaded, irregularly-sized, spiral threads. Last two whorls usually smoothly rounded, but may be slightly shouldered due to 2 to 4 strong spiral cords below the impressed suture. Body whorl may be smooth or with numerous fine, incised lines, or with numerous crowded, coarse, spiral cords which may be smooth or weakly beaded. Spire with 1 to 5 former varices. Color cream, whitish or bluish gray and with or without 5 or 6 spiral rows of small or large yellowish to reddish brown spots which may coalesce spirally or axially. Last varix of varying thickness, white or with brown or mauve color bars. Inside of outer lip white and with weak or strong, numerous, small teeth. Inside of aperture white, tan or brown. Parietal wall with a weak or fairly strong glaze. Columellar shield with a sinuous, elevated left edge, and bearing rugose, irregular, white lirae. True and false umbilicus deep, open and narrow. Channel posterior to the siphonal canal usually well-developed. Operculum yellowish and smoothish, except for concentric growth lines.

**Measurements (mm.)—**

length	width	no. whorls	
71.5	49.8	8	lectotype of <i>japonica</i> Reeve
71.0	46.2	8	large; Kyushu Id., Japan
68.0	44.0	8	holotype of <i>diuturnum</i> Iredale
59.0	39.5	6+	holotype of <i>nashi</i> Iredale
45.3	30.8	8	holotype of <i>booleyi</i> Sowerby
40.5	28.0	7	lectotype of <i>bisulcata</i> S. and W.
23.4	16.7	6	small; Jesselton, N. Borneo

**Nomenclature**—When Iredale in 1927 described his *diuturnum* from Australia, he interpreted Reeve's first application of the name *Cassis pila* on plate 5 of the *Conchologia Iconica* as technically a new name for figure 350, pl. 34, vol. 2 of Martini's *Conchylien-Cabinet* and for

vignette 18, figs. 1 and 2 on page 10. The latter is a reproduction of a living animal of Columnnae's "Buccini Neapolitani" from the Mediterranean [i.e., *Semicassis saburon* (Bruguère)]. Martini's figure 350 could be either *saburon* or the West Indian *Phalium granulatum* (Born). Martini's reference to the West Indies is taken from Valentyn (1773) and probably refers to the shell in figures 344 and 345, and not as Iredale supposed, to 350. However, the problem is not the true identity of these figures, but is whether or not Reeve's clumsy wording should be construed to mean that the name *pila* should apply to earlier, conflicting figures or be reserved for the shell he figured the next month, under the name of *pila*, on plate 9, figure 21. Everyone realizes that Reeve intended to name the shell from China in figure 21 as *pila*, and for this reason, I suggest that Reeve is saying that his not hitherto described species ("which I propose to distinguish by the name *C. pila*") only appears to correspond with Martini's figures. In fact, Reeve states that *saburon* (Reeve's species and figure 11) is well-illustrated by Martini's figure 350 and by the vignette 18. If Reeve had thought that his new *pila* was really represented by Martini's figures, he probably would have placed those references under the formal description of his *pila* on plate 9. I consider Reeve's *pila* on his plate 9, figure 12, and Iredale's *diuturnum* synonyms of *bisulcatum* Schubert and Wagner, 1829.

I disagree with Iredale's (1927, p. 336) interpretation of Schubert and Wagner's figures on their plate 223. I have seen their specimens in Copenhagen. None appears to be West Indian, except for figure 3083 which is *Cassis flammea* Linné. Figures 3077 and 3078 are the weakly-colored, spirally lirate form of *bisulcata* and are Iredale's form *diuturnum*. Figures 3084 and 3085 (*pomum* S. and W.) are the heavy, Mediter-

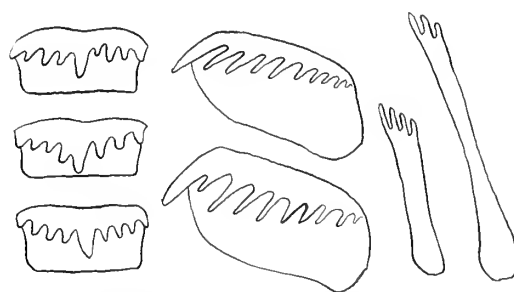


Plate 107. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner). Radular variations in an immature specimen from Sagami Bay, Japan.



Plate 108. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). A malformed specimen from off Anping, western Taiwan Island. Courtesy of Mrs. Orville Davis. 43.2 mm. in length.

anean *saburon* (Bruguière). Figures 3079 and 3080 are *canaliculatum* (Bruguière). Figures 3081 and 3082 (*bisulcatum* S. and W.) are what Sowerby named *booleyi* in 1900.

The name “*persimilis* Kuroda MS” was introduced in 1955 and first validated with a description in 1959 by Kira in his “Coloured Illustrations of Shells of Japan”. It refers to a moderately large, light-weight shell which is lightly spotted and lacks former varices. I have before me a suite of 9 specimens from Mogi, Nagasaki Prefecture, Japan, and consider them merely a form which is almost indistinguishable from the Australian form *diuturnum* Iredale. Two Mogi specimens are on our plate 5, figs. 20, 21. A specimen from Vatia, Fiji, kindly loaned to me by Walter O. Cernohorsky, is also very close to the form “*persimilis*”.

#### Synonymy—

- 1815 *Buccinum areola* L., Burrows, Elements of conchology, London, pl. 16, fig. 2; 1820, Wodarch, Introd. Study Conchology, London, pl. 3, fig. 39.
- 1825 *Buccinum tessellatum* Wood, Index Testaceologicus, London, p. 105, no. 27, pl. 22, fig. 27 (Amboyna). Not *B. tessellatum* Gmelin, 1791; not *Cassis tessellata* Pfeiffer, 1840.
- ?1828 *Cassis scrobiculata* Menke, Synopsis Methodica Molluscorum, Pymont, p. 36 and 86 (ad Javam); 1830, ed. 2, p. 63 and 144. [nomen oblitum].
- 1829 *Cassis bisulcata* Schubert and Wagner, Conchyl.-Cab., Nurnberg, vol. 12, p. 68, figs. 3081, 3082 (no locality). [smooth form].

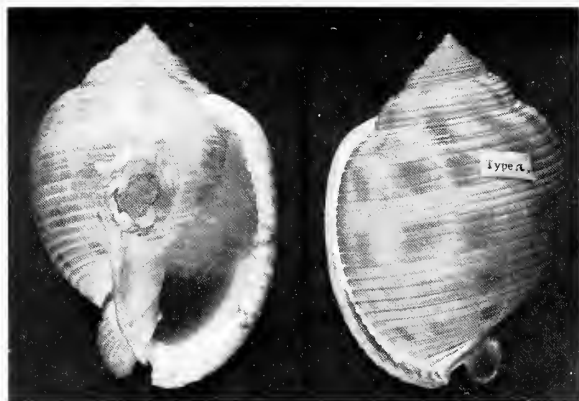


Plate 109. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Holotype of *Cassis japonica* Reeve in the British Museum (Natural History). 71.5 mm. in length.

- 1829 *Cassis saburon* Lam., Schubert and Wagner, *ibid.*, p. 66, figs. 3077, 3078. [sulcate form; spotless].
- 1848 *Cassis pila* Reeve, Conchologica Iconica, vol. 5, Cassis, pl. 5 and pl. 9, fig. 21, (China) [sulcate; spotted; lightweight form]; 1942, Yen, Proc. Mal. Soc. London, vol. 24, pl. 17, fig. 105 of holotype.
- 1848 *Cassis japonica* Reeve, Conchologica Iconica, vol. 5, Cassis, pl. 9, fig. 23b (China and Japan).
- 1857 *Cassis saburon* Brug., Küster, Martini and Chemnitz System. Conchyl.-Cab., second series, vol. 3, pt. 1b, p. 38, pl. 51, figs. 7, 8.
- 1857 *Cassis pila* Reeve, Küster, *ibid.*, p. 39, pl. 51, figs. 9, 10.
- 1857 *Cassis nucleus* Küster, *ibid.*, p. 43, pl. 52, figs. 3, 4.
- 1857 *Cassis japonica* var. *minor* Küster, *ibid.*, p. 43, pl. 52, fig. 9 (Japanese coast).
- 1871 *Cassis pfeifferi* Hidalgo, Journal de Conchyl., Paris, vol. 19, p. 226 (in *insularis* Philippines?); 1872, *ibid.*, vol. 20, p. 143, pl. 7, fig. 2 [sulcate; spotted; heavy form].
- 1888 *Favrotis bisulcata* Sowerby, Jousseaume, Mém. Soc. Zool. de France, vol. 1, p. 188 [error in author].
- 1896 *Cassis pfeifferi* Crosse, Sowerby, Proc. Malacological Soc. London, vol. 2, p. 14 [error in authorship].
- 1900 *Cassis booleyi* Sowerby, Journal of Malacology, vol. 7, no. 7, p. 163, text fig. (Port Blair, Andaman Islands). [smooth; spotted].



Plate 110. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Holotype of *Xenogalea nashi* Iredale in the Australian Museum no. C. 57789 from Sydney Harbour, Australia. 59 mm. (photos courtesy of D. F. McMichael).



- 1920 *Cassis* (*Semicassis*) *pila* Reeve, Tesch, Paläontologie von Timor, Stuttgart, vol. 8, pt. 14, p. 44, pl. 129, fig. 157 (Pliocene, Timor).
- 1927 *Semicassis diuturna* Iredale, Records Australian Museum, Sydney, vol. 15, p. 335, pl. 32, fig. 9 (Port Stephens, New South Wales, Australia).
- 1931 *Xenogalea nashi* Iredale, Records Australian Mus., Sydney, vol. 18, p. 214, pl. 23, fig. 18 (Sydney, New South Wales).
- 1933 *Cassis suburnon* [sic] var. *pila* Reeve, Yen, Second Ann. Report Marine Biol. Assoc. China, Peiping, pt. 1, p. 60 (Amoy, China).
- 1933 *Cassis japonica* Reeve, Yen, loc. cit., p. 61 (Amoy, China).
- 1943 *Phalium* (*Semicassis*) *pila* (Reeve), Altena, Leidsche Geolog. Mededeel., Leiden, vol. 13, p. 93 [fossil synonymies].
- 1955 *Semicassis persimilis* "Kuroda" Kira, Coloured Illustrations, Shells of Japan, Osaka, p. 43, no. 3, pl. 21, fig. 3 (nude name).
- 1959 *Semicassis persimilis* "Kuroda" Kira, loc. cit., 2nd ed., pl. 21, fig. 3, p. 43 (Japan, 10-20 fms.).
- 1960 *Semicassis pila* (Reeve), MacNeil, U.S. Geol. Survey, Prof. Paper 339, p. 58, pl. 13, figs. 2, 3 (Shinzato tuff, Okinawa).

**Types**—No type locality was given for *bisulcatum* Schubert and Wagner. We hereby designate Port Blair, Andaman Islands, as the type locality. The type is in the Zool. Mus. Copenhagen. The types of *pila* Reeve and *japonicum* Reeve are in the British Museum (Natural History) in London. The Australian Museum in Sydney contains the holotypes of *nashi* Iredale (C. 57789 and *diuturnum* Iredale (C. 53268). Kira's type of *persimilis* may be lost.

**Selected records**—(for other specimens examined, see solid dots on accompanying map) SOUTH AFRICA: Durban, Natal (J. H. Dale, Durban Mus.; Ponsonby, Brit. Mus.). ZANZIBAR: 8 fms., 2 mi. W.S.W. of Ras Mungive (A. J. Osheimer, 3rd, ANSP). MADAGASCAR: 22 fms., 32 mi. S.W. of Nossi-bé (R. E. M. Osheimer, R. W. Foster and M. Buerk, ANSP). PERSIAN GULF: 73 meters, of Sharjah, Oman Trucial (John Murray Exped., Sta. 72, Brit. Mus.). GULF OF OMAN: 43 and 52 fms., 47 to 25 mi. east of Dibbah, Saudi Arabia (Anton Bruun stations 255A and 262A). INDIA: Karikal (Dautzenberg coll'n., Mus. Royal Hist. Nat. Belgique); Madras (R. Winckworth, BM). BURMA: 37 fms., 35 mi. west of Tavoy Id., (Anton Bruun Sta. 36A, Mar. 30, 1963. 55 meters, 75 mi. W.S.W. of Akyab (Anton Bruun Sta. 49, Apr. 5, 1963). THAILAND (Andaman Sea): Patong Bay, Phuket (R. T. Abbott, Feb. 1963, ANSP). (Gulf of Siam); Koh Samet (H. M. Smith, USNM). MALAYA: Batu hitam, Pahang (R. D. Purchon, 1960, ANSP). JAPAN: Togi, west Honshu Id. (Brian Kane, 1966, ANSP). CHINA: Kwangtung and Sin-Tsung, Hainan Id. (A. D. Scarlato, Zool. Inst. Leningrad); Canton; Swatau (both Zool. Mus., East Berlin). PALAU IDS.: Malakal Harbor, Koror Id. (Johnson and Bridges, 1947, USNM). RYUKYU IDS.: Kaneko, Oki Id. (Anita Scott, coll'n.). PHILIPPINES: common throughout all the islands from 10 to 190 fathoms. 190 fms., Tayabas Bay, Luzon Id., Albatross Sta. 5374; 182 fms., N.E. of Tagola, Mindanao Id., Albatross Sta. 5519; 34 fms., off Tawi Tawi Id., Albatross Sta., 5152; also at other Albatross stations in the Philippines; Sta. 5187 (225 fms., dead); 5220 (50 fms., soft green mud); 5257 (28 fms., gray mud); 5272 (118 fms.); 5278 (102 fms.); 5279 (117 fms., gray mud); 5335 (46 fms., sandy mud); 5353 (148 fms.); 5369 (106 fms.); 5371 (83 fms., soft green mud); 5376 (90 fms., gray mud-

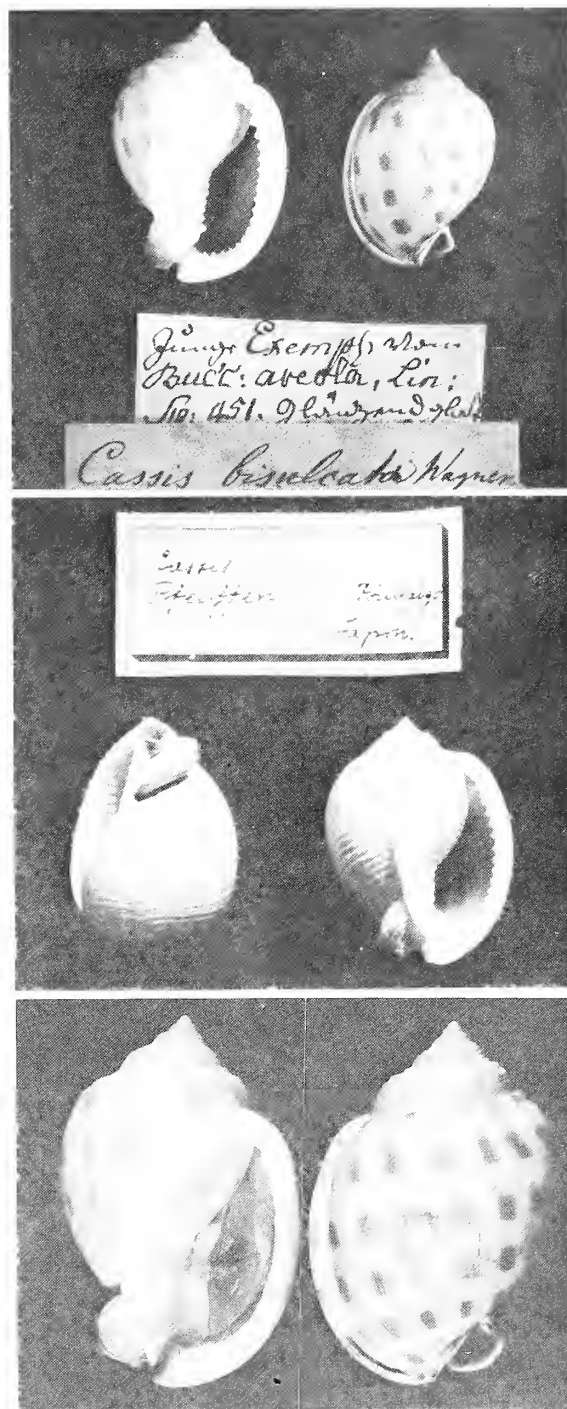


Plate 111. *Phalium* (*Semicassis*) *bisulcatum* (Schubert and Wagner, 1829). Top figs., syntypes of *Cassis bisulcata* Schubert and Wagner. Zool. Mus. Copenhagen. 40.5 mm. (left). Center figs., syntypes of *Cassis pfeifferi* Hidalgo, 1871, in Museo de Ciencias Naturales de Madrid. 51 mm. Bottom figs., holotype of *Cassis booleyi* Sowerby, 1900, Port Blair, Andaman Islands, in British Museum (Natural History). 45.3 mm.



Plate 112. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Holotype of *Semicassis diuturna* Iredale, Australian Museum no. C. 53268, from Port Stephens, New South Wales, Australia. 68 mm. (photo courtesy of D. F. McMichael).

sand); 5426 (27 fms. dead); 5642 (37 fms., gray mud). INDONESIA: 37 fms., gray mud, Buton Straits, Celebes Id. (Albatross Sta. 5642) (all USNM). 44 meters, 140 mi. N.W. of Djakarta, Java (Galathea Sta. 457, 1952, Zool. Mus. Copenhagen). NORTH BORNEO: Tonjong Aru, Jesselton; Maruda Bay (both Mary Saul, ANSP). AUSTRALIA: 23 fms., off Legendre Id., Dampier Archip., Western Australia (C. S. Weaver and Mariel King, 1960, BPBM). 16 fms., off Flat Top Bank, 16 fms., off Arnhem Land, 18 fms., off Liverpool River, all Northern Territory (all Vernon Wells, ANSP). Off Evan's head, New South Wales (T. A. Garrard, MCZ). SOLOMONS: Ataa, Malaita Id. (van der Riet, ANSP). FIJI: Vatia wharf, Viti Levu

Id. (W. O. Cernohorsky coll'n). MARSHALL IDS.: 46 meters, sand and silt, lagoon, 2 mi. N.N.W. of Iguin Id., Eniwetok Atoll (E. J. Kuenzler, 1960, ANSP). BAY OF BENGAL: (all Anton Bruun Stations, International Indian Ocean Exped., Mar.-April, 1963) off Phuket Id., Sta. 19, 42 meters, Sta. 20, 58 meters in clay-mud; 30 mi. west of Twin Id., Burma, Sta. 22B, 274-293 meters in sand-mud, 12 mi. N.W. of Port Blair, off South Andaman Id., Sta. 28, 90 meters in sand; 25 mi. N.W. of Port Blair, Sta. 28c, 38 meters, sand; 35 mi. west of Tavoy Id., Burma, Sta. 36a, 68 meters, mud; 57 mi. N.W. of Tavoy Id., Sta. 37, 39 meters in sand; 35 mi. S.E. of Irrawaddy R., off Burma, Sta. 41a, 22 meters in gray mud; 17 mi. S.S.E. of Akyab, north Burma, Sta. 49, 55 meters in muddy sand; 10 mi. S.E. of Vizagapatnam, N.E. India, Sta. 89, 58 meters in sand.

### Fossil Synonymy

- 1879 *Cassis herklotsi* K. Martin, Die Tertiärschichten auf Java, p. 45, pl. 8, figs. 7, 7a (Upper Miocene; Tjikarang, Java); 1908, K. Martin, Versl. Vergad. Kon. Akad. v. Wet., Afr. Nat., p. 9 (Sondé, Java; Pliocene); 1919, Unsere Palaeozool. Kenntnis von Java, pp. 88, 141, 154 (Pliocene; Java). [see pl. 113].
- 1899 *Cassis (Semicassis) pila* Reeve, var., K. Martin, Samml. Geol. Reichs-Mus. Leiden, N.F., vol. I, p. 154, pl. 24, figs. 356-359 (Sondé, Java; Pliocene); 1962, Dey, Palaeontologia Indica, Mem. Geol. Survey India, new series, vol. 36, p. 68, pl. 5, fig. 13 (Miocene; Quilon beds, Kerala, India).
- 1927 *Cassis (Semicassis) japonica* Reeve var. *minor* Kuster, P. J. Fischer, Paläontologie von Timor, Lief. 15, Abh. 25, p. 61, pl. 212, figs. 28a, b, 29a, pl. 213, figs. 29b, 30a, b (Ceram; Pliocene); 1931, Koperberg, Jaarb. Mij. Ned.-Indie for 1930, first Verhandel., p. 122 (Timor, Tertiary).
- 1943 *Phalium (Semicassis) japonicum herklotsi* K. Martin, Altena, Leidsche Geol. Mededeelingen, vol. 13, p. 95.
- 1943 *Phalium (Semicassis) pila* (Reeve), Altena, *loc. cit.*, p. 93.
- 1948 *Phalium (Semicassis) pila* (Reeve), Cox, Schweizerische palaeont. Abhandl., vol. 66, p. 36, pl. 1, figs. 92, b (7 km. west of Dent Haven, N.E. North Borneo; Upper Miocene or Pliocene); 1942, Altena, Leidsche Geol. Mededeelingen, vol. 13, p. 93.
- 1899 *Cassis (Semicassis) rembangensis* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 1, pt. 1, p. 155, pl. 24, fig. 362 (Sedan and Punkte, Gunung Butak, Pamotan, Java [Pliocene]). Smooth form.

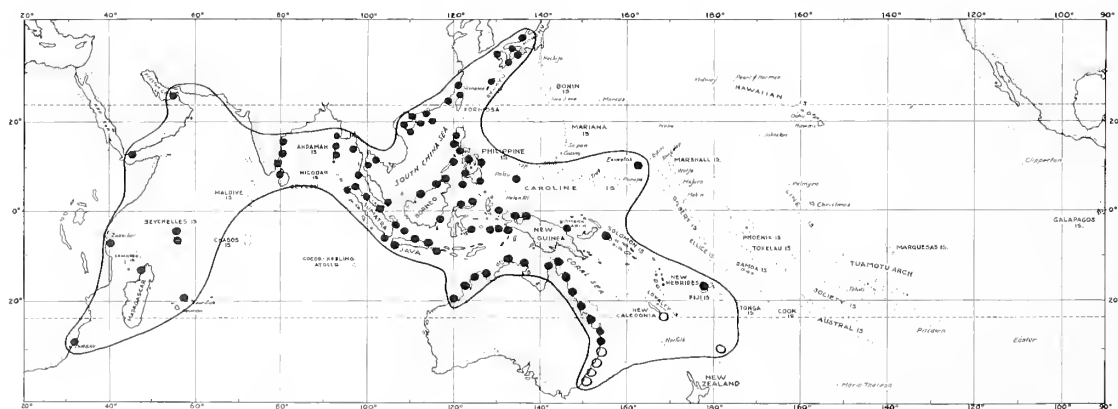


Plate 113. Geographical distribution of *Phalium (Semicassis) bisulcatum* (Schubert and Wagner) shown in solid dots.

The subspecies or possible hybrid, *sophia* (Brazier) are shown as open circles at the southeast range of *bisulcatum*.



- 1935 *Phalium (Semicassis) japonicum* Reeve, Nomura, Tohoku Imperial Univ. Science Reports, series 2, Geology, vol. 18, no. 2, p. 170 (Pliocene of Taiwan).  
 1948 *Phalium (Semicassis) dalrymplei* Cox, loc. cit., p. 37, pl. 1, figs. 10a, b (7 km. west of Dent Haven, N.E. North Borneo; Upper Miocene or Pliocene).  
 1962 *Cassis (Semicassis) quilonensis* Dey, loc. cit., p. 69, pl. 5, figs. 20, 26 (Miocene; Quilon beds, Kerala, India).

*Fossil records*—JAPAN: Lower Pliocene: Sirado Beds at Tennoyama, Totomi Prov., Honshu, (J. Makiyama, 1927, Mem. College Sci. Kyoto Imp. Univ., ser. B., vol. 3, no. 1, p. 72). PHILIPPINES: Upper Miocene-Pliocene at Cotabato, Mindanao Id. (W. D. Smith, 1913, pp. 254, 263, pl. 5, fig. 6). INDONESIA: Miocene, Pliocene and Pleistocene of Java, Sumatra, Ceram and Timor (see details in Altena, 1943, pp. 93-96, under *pila* and *herklotsi*). TAIWAN: Pliocene, Byoritu Beds of Wangwa, Kokwan, etc. (Nomura, 1935, vol. 18, p. 170).

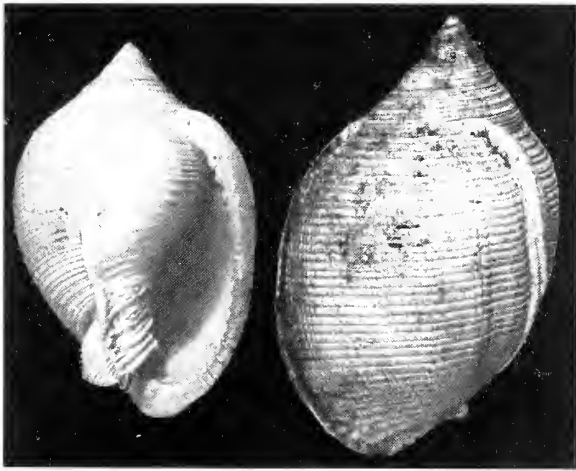


Plate 114. *Phalium (Semicassis) bisulcatum* (Schubert and Wagner, 1829). Miocene of Java, Indonesia. Holotype of *Cassis herklotsi* K. Martin, 1879.

### *Phalium bisulcatum subspecies sophia* (Brazier, 1872)

(Pl. 8, fig. 12; pl. 115, figs. 1-8)

*Range*—Southern Queensland and New South Wales, Australia, and the Kermadec Islands.

*Remarks*—From southern Queensland to New South Wales, and evidently in the Kermadec Islands, there is a distinctive form which tends towards a large size, tabulate shoulders, smoothish surface and axial color bands. The shells are puzzling in two respects. Smaller, heavier specimens (off Moreton Bay, Brisbane) bear a striking resemblance to variants of *bisulcatum* from Madagascar and the Andamans; and larger, lighter-weight specimens (off Tweed Head and Trial Bay, New South Wales) give the impression that they are the result of hybridization with the cool-water *pyrum* complex. In 1910, Iredale noted this latter relationship by considering *sophia* as a subspecies of *pyrum* but he later (1927) raised *sophia* to species rank. *S. sophia* exhibits variations in the labial teeth (from strong to a few weak ones or even obsolete) and in the degree of rugosity of the columellar shield (from strong rugae as in typical *bisulcatum* to a smoothish columella as in many *pyrum*). Northern specimens have the squarish spots of *bisulcatum*, but southern shells show a gradual increase in irregular, axial brown flames as in some *pyrum*. Short of breeding experiments, the placement of *sophia*, whether as a full species, as a subspecies of *bisulcatum* or as a hybrid, *bisulcatum* X *pyrum*, is purely arbitrary.

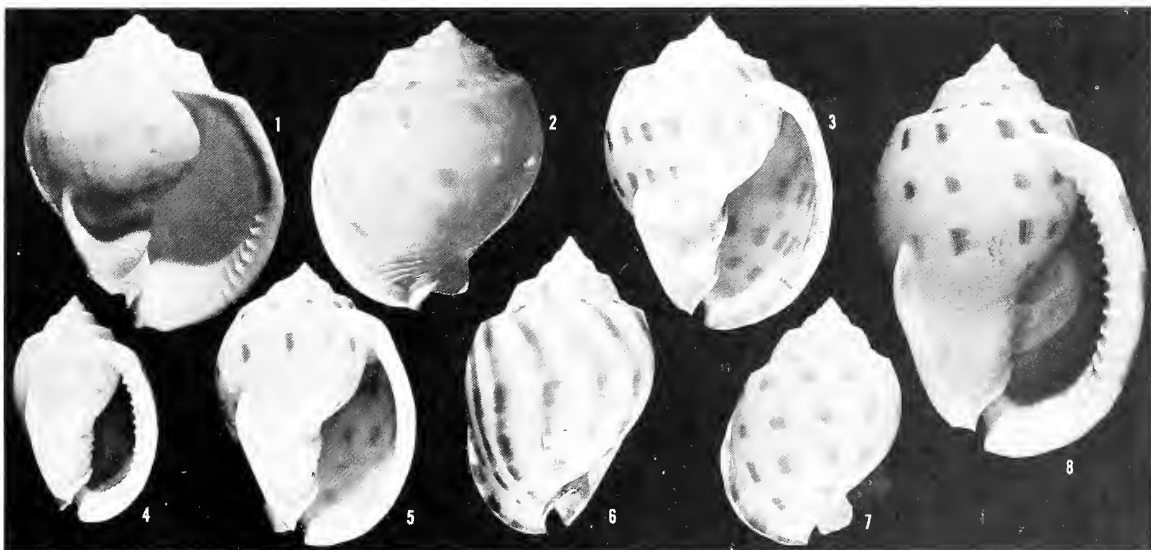


Plate 115. *Phalium (Semicassis) bisulcatum* subspecies *sophia* (Brazier, 1872). Variations in shape, color patterns and sculpturing. Figs. 1, 2, holotype of *Cassis sophia* Brazier in

the Australian Museum no. C. 30751. 79 mm. Figs. 3-8, specimens from off New South Wales and Queensland, Australia. (courtesy of Joy Kerslake).



I am following Iredale (1927, p. 343) in using the spelling "*sophia*" which was the original one. A year after he described the species, Brazier corrected the spelling to "*sophiae*."

**Description**—Shell 58 to 79 mm. (2¼ to 3 inches) in length, globose, thin- to thick-shelled. Cream to whitish background with 6 spiral rows of squarish and reddish brown spots which may be axially joined with wavy, broad, reddish brown flames or bands. Whorls 7 to 8, weakly or strongly flattened or tabulate just below the suture where there are 3 to 6 irregularly-sized, smoothish, rounded, spiral cords. Parietal shield and its left edge moderately to strongly developed. Columella with oblique sulcations and broken rugae, but in some specimens half-smooth or entirely smooth. Outer lip or varix thin or thick, in the latter case having weak or strong, white, spiral dentitions. Inner and upper parietal wall may or may not bear 2 or 3 short, oblique rugae. Siphonal canal short, recurved and faintly tinged with lavender-brown in back of the rounded, posterior opening (not black-tipped). Canal bordered posteriorly by a well-marked gutter which runs posteriorly into the deep, true umbilicus. False umbilicus narrow and deep. Base of body whorl with 3 to 6 microscopic, incised spiral lines.

**Habitat**—Dredged in 40 to 80 fathoms, presumably on sand bottoms.

**Measurements (mm.)—**

		no.	
length	width	whorls	
79.0	65.0	5+	large; holotype, Australian Mus.
78.0	62.0	6+	large; Trial Bay, New South Wales
74.1	51.9	8	average; Tweed Head, N.S.W.
74.0	52.0	8	average; Southport, Queensland
61.5	43.7	7	small; Caloundra, Queensland
60.5	42.5	8	small; Trial Bay, N.S.W.
57.9	37.3	7	small; Moreton Bay, Brisbane, Qld.

**Synonymy—**

- 1872 *Cassis sophia* Brazier, Proc. Zool. Soc. London for 1872 (Nov.) p. 617, pl. 44, fig. 2 (under Grassy Head, mouth of Macleay River, New South Wales).  
 1873 *Semicassis (Casmaria) sophiae* Brazier, loc. cit., p. 838, no. 8.  
 1910 *Cassidea pyrum sophiae* Brazier, Iredale, Proc. Mal. Soc. London, vol. 9, p. 71 (Sunday Island, Kermadec Islands).  
 1915 *Cassidea pyrum* Lamarck, Oliver, Trans. and Proc. New Zealand Inst., vol. 47, p. 529 (Kermadec Islands).  
 1918 *Phalium sophia* Brazier, Hedley, Journ. Royal Soc. New South Wales, vol. 51, p. M. 67.  
 1927 *Xenogalea sophia* Brazier, Iredale, Records Australian Mus., vol. 15, p. 343, pl. 32, fig. 12, the holotype.

**Types**—The locality is Grassy Head, Macleay River, New South Wales, Australia. The holotype

of *sophia* is in the Australian Museum in Sydney, no. C. 30751.

**Records**—KERMADEC ISLANDS (600 mi. N.E. of New Zealand): Sunday (or Raoul) Island (Iredale, 1910, p. 71). AUSTRALIA: QUEENSLAND: Peel Id., Moreton Bay, near Brisbane (Iredale, 1927, p. 344); Caloundra (Joy Kerslake coll'n; Aust. Mus.); Southport (Joy Kerslake coll'n); off Cape Moreton (ANSP, pl. 5, fig. 12). NEW SOUTH WALES: Trial Bay; Tweed Head (both Joy Kerslake coll'n.); off Green Cape (Iredale, 1927, p. 344; Macleay River (Aust. Mus.); off Port Jackson, Sydney (Aust. Mus.).



Plate 116. *Phalium (Semicassis) canaliculatum* (Bruguère, 1792). Holotype, 49.0 mm. in length. Mus. d'Hist.Nat.Genève.

***Phalium canaliculatum* (Bruguère, 1792)**

(Pl. 8, figs. 5, 6; pl. 116)

**Range**—Bay of Bengal (and the Philippines?).

**Remarks**—*P. canaliculatum* (Bruguère) is very closely related to *S. bisulcatum* (Schubert and Wagner), but differs in having a deep, wide, V-shaped channel at the suture in the last two whorls. Its otherwise smooth body whorl bears 16 to 18 fine, incised spiral lines which are evenly spaced apart. The varix is usually heavy and recurved. In coloration and rugosity of the columellar shield, it is similar to many specimens of *bisulcatum*.

Authentic records of this species exist for the western section of the Bay of Bengal, from Cey-

lon north to Madras. I question the Philippines records in the literature (de Elera, 1896, p. 225), because these may well be based upon specimens of *bisulcatum*. Staub reported this species from the east side of Borneo (1916, p. 125), but I believe this and other uses of the name *canaliculatum* for probable specimens of *bisulcatum* (Schubert and Wagner) are due to the use of Küster's poor figures (1857, vol. 3, part 1b, pl. 43, figs. 3 and 4).

The only shell difference between *bisulcatum* and *canaliculatum* is the presence of a sub-sutural channel in the latter. Some workers may wish to consider this difference as only of sub-specific importance. The species is common offshore in the region of Madras, India (Hornell, 1951, p. 23).

**Description**—Shell 35 to 53 mm. (about 1½ to 2 inches) in length, globose, with a thin but strong shell; deeply channeled at the suture; with a denticulate outer lip, and with a well-developed, rugose parietal shield. Nuclear whorls 3, bulimoid, smooth, opaque and milk-white. First few postnuclear whorls with 6 to 8 minute, spiral threads which may or may not be crossed by retractively slanting, axial threads. Last whorl with 17 to 20 incised, spiral lines. Suture deeply channeled below. Color of shell cream with 4 or 5 spiral rows of small, squarish, light yellow-orange spots. Outer lip with 17 to 20 fairly strong white teeth on the inner edge. Columellar shield strongly rugose. True and false umbilicus small, but deep. Left edge of parietal shield wavy, but not with projections. Operculum unknown.

**Measurements (mm.)—**

length	width	no. whorls	
53.5	35.0	7	large; India
49.0	35.9	5+	Bruguière's type
45.0	31.0	7	average; Ceylon
34.5	24.0	7	small; Ceylon

**Types**—No type locality was given by Bruguière. Lamarck gave "Ceylon" which we designate as the type locality. Bruguière's type is in the Museum de Genève (1962).

**Synonymy—**

- 1792 *Cassidea canaliculata* Bruguière, Encyclopédie Méthodique, vers, vol. 1, pt. 2, p. 423 (locality unknown).  
 1822 *Cassis canaliculata* Brug., Lamarck, Anim. sans Vert., vol. 7, p. 228 (Côtes de Ceylan); 1829, Schubert and Wagner, Neues Syst. Conchl.-Cab., vol. 12, p. 67, pl. 223, figs. 3079, 3080; 1834, Kiener, Coquilles Vivantes, Paris, vol. 7, Cassis, p. 32, pl. 14, fig. 28.

1935 *Phalium (Semicassis) canaliculatum* (Bruguière), Bayer, Zoologische Mededeelingen, vol. 18, p. 101; 1942, Gravely, Bull. Madras Gov't. Mus., new series, Nat. Hist., vol. 5, no. 2, p. 42 and 97.

**Records**—INDIA: Madras (R. Winckworth, BM) (Melvill and Standen, 1898, Jour. of Conch., vol. 9, p. 44; Hornell, 1951, p. 23; Gravely, 1942, p. 42; Adyar, near Madras (Zool. Mus. Amsterdam); Karikal (Dautzenberg, coll'n., Bruxelles). CEYLON: Sweat Bay, Trincomalee (A. J. Kohn, Yale Peabody Mus.). PHILIPPINES: Mindoro Id.; Cebu Id.; Dapitan, Mindanao Id. (all de Elera, 1896, p. 225). [probably *bisulcatum* S. and W.J. Roxas, (Capiz), Panay Id. (H. M. Woolsey, coll'n., Yale Peabody Mus.) [locality accurate?].

**Fossil records**—None reported.



Plate 117. *Phalium (Semicassis) faurotis* (Jousseaume, 1888). Fig. 1, holotype of *Faurotis faurotis* Jousseaume, 1888, Mer d'Aden, 49.1 mm. Mus. d'Hist. Naturelle Paris. Figs. 2, 3, specimen from Scottsburg, Natal, South Africa, 43 mm.

***Phalium faurotis* (Jousseaume, 1888)**

(Pl. 8, figs. 3, 4; pls. 117-119)

**Range**—Western end of the Indian Ocean.

**Remarks**—This uncommon species is readily distinguished from its nearest ally, *bisulcatum* (Schubert and Wagner), by its bluish black or purple-brown apex, in having 3 to 5 large, rounded knobs or fingertip projections on the left border of the columellar shield, and in lacking a

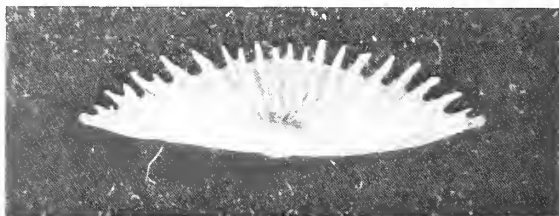


Plate 118. Operculum of *Phalium* (*Semicassis*) *faurotis* (Jousseaume). Durban, South Africa. Shell, 49 mm.; operculum, 14.8 mm.

relatively wide channel or groove at the base of the last whorl just posterior to the lower, right margin of the siphonal canal. *S. faurotis* is variable in its degree of spiral sculpturing and intensity of color-spotting, but I have seen no completely smooth forms, nor fresh specimens which lacked coloration. I have not seen specimens over 66 mm. in length. It is the only species of Cassidae with darkly colored nuclear whorls. Its operculum is strongly fimbriated with about 22 long, chitinous denticles.

I believe Cuming's locality and that of a specimen in the ANSP collection of "Manila, Luzon Island" are probably erroneous. Azpeitia (Moros) in 1925 figured Hidalgo's type of *Cassis crosseii* and pointed out that the origin of that specimen was the Red Sea and not the Philippines. It is a synonym of *faurotis* (Jousseaume). It is for this reason that Hidalgo did not include *crosseii* in his 1904-1905 "Catalogo Moll. Test. de las Islas Filipinas."

**Habitat**—This species has been dredged on gray sand bottoms from 6 to about 160 fathoms. Rarely, it is cast ashore. It occurs with *P. bisulcatum*.

**Description**—Shell 37 to 61 mm. (1-1/2 to 2-1/2 inches) in length, globose, solid, cream with reddish spots, with finger-like projections on the left edge of the columellar shield and with a dark apex. Nuclear whorls 3, bulimoid, glossy, and purple-brown. Postnuclear whorls with 5 to 8 minute spiral threads between which are numerous, microscopic axial growth lines which may produce weak beading. Last whorl cream to tan with a blush of grayish on the dorsal side, with 5 spiral rows of square, reddish brown spots, and with numerous spiral, incised lines. Outer lip with 14 to 18 small, white teeth. Columellar shield rugose and with 3 to 5 large, rounded knobs on the left edge. Umbilicus open; false umbilicus narrower and sealed in some specimens. The channel posterior to the siphonal canal is very narrow. Operculum strongly fimbriate.

#### Measurements (mm)

length	width	no. whorls	
65.7	43.1	8	large; Muscat
61.0	41.0	8	large; Aden
51.0	35.0	8	Aqaba, Red Sea
48.6	32.0	8	lectotype of <i>faurotis</i>
37.5	26.1	7	small; Indian Ocean

**Types**—The type locality is Aden. I am choosing Jousseaume's specimen in the Museum d'Histoire Naturelle in Paris as the lectotype. Its measurements are given above. I was unable to locate Hidalgo's type of *crosseii*.

#### Synonymy—

- 1848 *Cassis bisulcata* Schubert and Wagner, Reeve, Conch. Icon., vol. 5, Cassis, pl. 3, figs. 6a, 6b (Manila, Luzon Id.; Cuming) [?locality erroneous]; 1859, Chenu, Manuel de Conch., vol. 1, p. 207, fig. 1128.  
 1888 *Faurotis faurotis* Jousseaume, Mémoires Société Zoologique de France, vol. 1, p. 188 (east of Aden).  
 1896 *Cassis crosseii* Hidalgo, Journ. de Conchyl., vol. 44, p. 217, (in insulis Philippinis); 1923, Azpeitia (Moros), Revista de la R. Acad. de Cienc. Exact., Fisic. y Nat. de Madrid, vol. 21, p. 75; reprint, 1925, p. 155, pl. 1, fig. 4 (in color).  
 1939 *Cassis* (*Phalium*) *bisulcata* Sch. et Wg., Moazzo, Mém. l'Inst. d'Egypte, vol. 28, p. 164 (Moya Soukh, Suez).

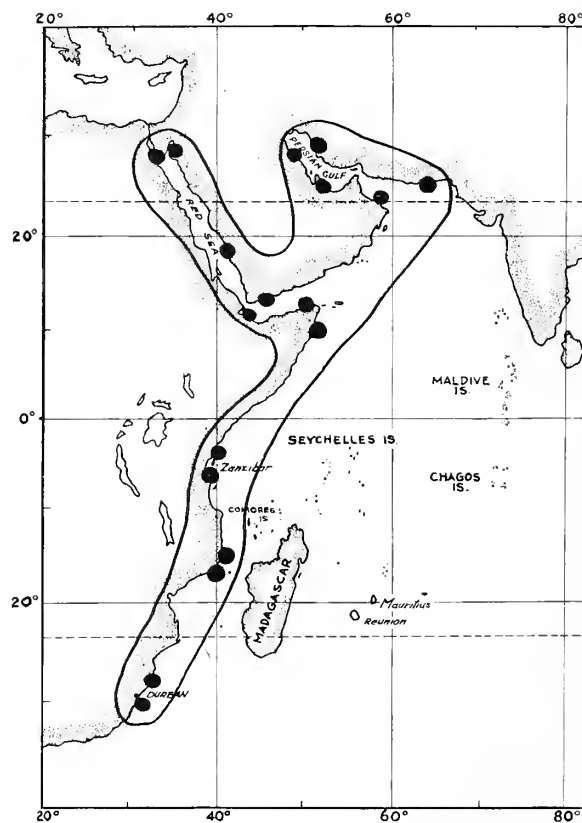


Plate 119. Geographical distribution of *Phalium* (*Semicassis*) *faurotis* (Jousseaume).



*Records*—SOUTH AFRICA: NATAL: Durban (H. C. Bur-nup, USNM; J. J. Ponsonby, Brit. Mus.); Scottsburg (Helen Boswell, coll'n.). PORTUGUESE EAST AFRICA: 20 meters, Nacala (F. B. Steiner, ANSP); Porto Amelia (W. E. Old, Jr., ANSP). ZANZIBAR: 1½ mi. N.W. of Chango Id.; 1½ mi. W.S.W. of Ras Mungive, 8 fms. (both A. J. Ostheimer, 3rd, ANSP). FRENCH SOMALIA: Loyada, near Djibouti (N. Lavergn, ANSP). SOMALIA: Candala (Carl Gans, MCZ); 47 meters, off Ras Binnah (Anton Bruun Sta. 9-453) ADEN: Kaymaksur (Rijksmus. Leiden). RED SEA: off Yemen, 375 meters, John Murray Exped. Sta. 207 (BM); Eilat, Gulf of Aqaba (A. Hadar, coll'n.). PERSIAN GULF: Safaniya, Saudi Arabia, 8 fms. (Jeanne Johnson coll'n); Kuwait (USNM); Isle of Khark, near Bushehr, Iran (G. Thorson, 22 meters, Mar. 24, 1937, Mus. Zool. Copenhagen). Muscat, Oman (D. T. Bosch, ANSP); 52 fms., 47.1 mi. east of Dubat Sharjah, Gulf of Oman. Anton Bruun station 255A (MCZ) WEST PAKI-STAN: near Karachi (Abdullah Mohammed El-Husseini, 1963, ANSP).

### *Phalium umbilicatum* (Pease, 1860)

(Pl. 8, figs. 10, 11; pl. 120)

*Range*—Known only from the Hawaiian Chain to Midway Island. Also in the Pleistocene on Lanai Island, Hawaii.

*Remarks*—This rare Hawaiian species is characterized by its heavy, globose, spirally-corded shell and by its highly ornamented operculum. The spiral cords are strongly developed even on the parietal wall and on the inside wall of the last whorl. The lower half of the apical whorls are usually colored mauve or purplish. In opercular characters, it most resembles *P. faurotis* of the western Indian Ocean.

This species was described twice, first by Pease in 1860, and later by E. A. Smith in 1904. It would appear that the same type specimen was used in the description.

*Description*—Shell 22 to 62 mm. (about 1 to 2½ inches) in length, solid, globose, spirally corded, brownish cream with weak or absent spottings. Nuclear whorls 3, glassy, smooth, bulimoid, slightly tilted, the upper half whitish, the lower half mauve or brownish purple. Apical whorls with 4 to 6 beaded, spiral threads. Last whorl rotund and bearing 17 to 19 strong, smooth, flat-topped, spiral cords. Aperture somewhat constricted. Varix heavy, recurved, its apertural side being enamel white and bearing 17 to 19 strong, white, sometimes bifurcate, spiral teeth which continue inside the aperture on the inside of the last whorl; its posterior side is wavy and marked with narrow, mauve stripes. Columellar shield well-developed and strongly liriate

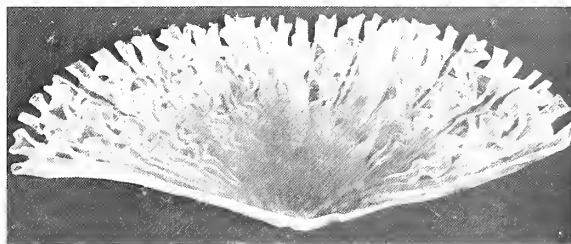


Plate 120. Operculum of *Phalium (Semicassis) umbilicatum* (Pease). 25.8 mm. Oahu Id., Hawaii. (photo by Jay Sacks).

and rugose. Parietal wall with spiral cords. True umbilicus very deep; false umbilicus narrower but as deep. Channel posterior to the siphonal canal deep and fairly broad. Color of shell brownish cream with a purple-gray blotch on the dorsal side of the penultimate whorl; weak orange-tan spots may be present on the last whorl. Operculum yellow and with numerous radial, tubular folds.

#### *Measurements (mm.)—*

length	width	no. whorls	
62.5	43.0	9	Pease coll'n. (MCZ)
55.9	39.5	8	Type of <i>fortisulcata</i> (BM)
38.1	26.0	7	small; Keehi, Oahu Id.
21.6	18.0	7	small; Keehi, Oahu Id.

*Types*—The type locality for *fortisulcata* is Kauai Island. Smith's type of *fortisulcata* is in the British Museum (Natural History) in London. Pease's type, also from the Cuming collection, is probably the same specimen. E. A. Smith read the name on Cuming's label of "Hanalei", a town on Kauai, and supposed erroneously that it was a manuscript name of "*Cassis hanclei*". The Museum of Comparative Zoology, Cambridge, Mass., contains two possible co-types of *umbilicata* from the Pease collection.

#### *Synonymy—*

- 1860 *Cassis umbilicata* Pease, Proc. Zool. Soc., London, for 1860, p. 436 (Sandwich Islands; Cuming collection).  
 1904 *Cassis (Semicassis) fortisulcata* E. A. Smith, Proc. Malacological Soc. London, vol. 6, p. 21, fig. (Kauai, Hawaiian Ids.; Cuming collection).  
 1958 *Semicassis fortisulcata* (E. A. Smith), Tinker, Pacific Sea Shells, Tuttle Co., p. 86, lower left figs.

*Records*—MIDWAY: R. A. Garratt, 1943 (USNM); Calif. Acad. Sci.; BPBM. KAUAI: Hanalei Mus. Cuming, Brit. Mus.). OAHU: Honolulu Harbor dredgings; 53 to 211 fms. off south coast, Albatross Station 3810; 33 to 50 fms. off Waiki-ki, Albatross Station 5508 b (all USNM); 10 to 40 fms. off Honolulu (Th. Mortensen, 1915, Zool. Mus. Copenhagen); 20 to 50 fms. off Keehi Lagoon (C. S. Weaver and Mariel King, 1959). MAUI: 10 fms., mud, off Lahaina (C. S. Weaver and Mariel King).

*Fossil Records*—PLEISTOCENE: 550 ft. alt., Lanai Island (Harold Stearns, USNM).

***Phalium multisectum* (Finlay, 1924)**

*Range*—Upper Pliocene, North Island, New Zealand.

*Remarks*—I agree with Powell (1928, p. 642) that this species should be placed near the Recent *bisulcatum* Schubert and Wagner, 1829 (of which *diuturnum* Iredale is a synonym). The longitudinal (axial) striae on the outside of the siphonal canal (fasciole) are characteristic of the *bisulcatum* group. However, the small nodules on the shoulder are unusual for Indo-Pacific *Semicassis*, and are reminiscent of the *Tylocassis* complex of the Recent Mediterranean and Caribbean. The possible relationship of *multisectum* with *Xenophalium thomsoni* should not be overlooked, for the latter species sometimes has rugae on the columellar shield and the general sculpture of the outer shell is sometimes similar to that of *multisectum*. Hutton's original description which was without an illustration was "*Cassis striatus*, sp. nov. Ovato-ventricose; spire rather concave; body whorl obsoletely plicated in front, and distantly spirally striated; spire spirally striated, cancellated by fine transverse [axial] ribs; columella rugose, outer lip smooth." Length, 1.1 inches; width, .8 inch. Type locality; Wanganui. In 1924, Finlay renamed this homonym as *multisectum*. Powell (1928, p. 642) illustrates and records additional specimens from Castlecliff (53 × 37 mm.) and Kai Iwi (34 × 23 mm.). This species is lighter in structure than *skinneri* Marwick, 1928.

***Synonymy*—**

- 1873 *Cassis striatus* Hutton, Cat. Tertiary Mollusca and Echinodermata of New Zealand, Wellington, p. 8 (Wanganui, Shakespeare Cliff). Non Sowerby, 1812.  
 1924 *Cassidea multisecta* Finlay, Proc. Mal. Soc. London, vol. 16, p. 101. New name for *Cassis striatus* Hutton, 1873, non Sowerby, 1812.  
 1928 *Semicassis multisecta* (Finlay), Powell, Proc. Trans. New Zealand Inst., vol. 59, p. 642, pl. 74, figs. 13, 14.

***Phalium skinneri* Marwick, 1928**

(Pl. 121)

*Range*—Lower Miocene, Chatham Islands, New Zealand.

*Remarks*—This solid, globose, 41 mm.-long cassid is very distinctive, and closely resembles the Recent European *saburon* in shape and apertural features. It differs in having strong axial threads which give the surface a rugose finish. The parietal shield is heavily callused as in

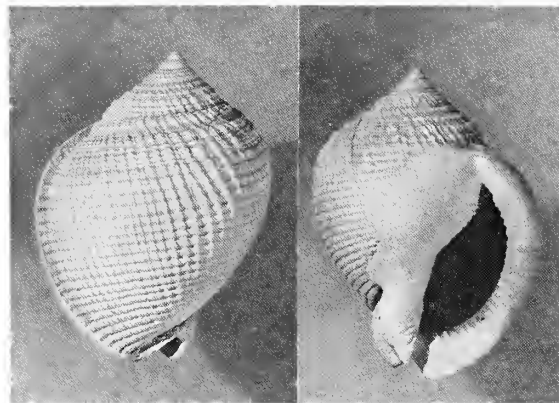


Plate 121. *Phalium (Semicassis) skinneri* Marwick, 1928. Lower Miocene, Chatham Islands, New Zealand. Holotype, 41.5 mm. (photos courtesy of the New Zealand Geological Survey).

*saburon*, but has a peculiar, U-shaped embayment on the left side, such as found in some Australian species. I can see no justification in retaining the subgenus *Kalua* which Marwick erected for this species. It seems to possess a combination of *Semicassis*, *Tylocassis* and *Xenophalium* characters.

*Description*—Shell (41 × 31 mm.) thick and strong; spire less than one-third height of aperture. Protoconch tectiform of about four smooth whorls with small nucleus. Post-embryonic whorls four, slightly convex on spire. Suture impressed. Sculpture: first whorl with two obsolete cords towards top of whorl; second with an additional thread near suture, all crossed by strong growth lines, on later whorls many additional spirals appear but the three primaries can be traced on body though upper is divided into 4, middle into 2, and lower into 2; interstices with additional threads (top one with 4, one stronger), below the third cingulum are 20 strong, broad spiral cords, with narrower interstices, some of the top ones being double. The spirals are regularly cancellated by strong bevelled ridges. Aperture deeply notched below; fasciole indistinctly spirally striated. Outer lip reflexed and much thickened to form strong varix, dentate within. Inner lip thickened, practically filling umbilicus but with no projecting platform; bearing about 16 waved threads of which 6 are on columella (from Marwick, p. 482).

***Synonymy*—**

- 1928 *Phalium (Kalua) skinneri* Marwick, Transactions and Proceedings New Zealand Institute, Wellington, vol. 58, p. 482, fig. 132 on p. 505 (Pitt Island, Whenuatara Peninsula, Chatham Ids., New Zealand; Tertiary).

**Phalium microstoma (von Martens, 1903)**

(Pls. 122-123)

**Range**—Deep-sea off Tanganyika to Somalia, East Africa (200-1134 meters).

**Remarks**—This species is known from only a few specimens, and it appears to be related to *S. craticulatum* Euthyme of South African waters. *S. microstoma* is characterized by its rather heavy shell, by its evenly-ovoid shape, by the 24 to 27 rather strong, even-sized spiral cords on the body whorl, by the very rugose columellar shield and by the strong spiral teeth which cross the thick outer lip. Like *craticulatum*, it has a rugosely toothed ridge on the inner, lower section of the columella. I examined von Marten's type series in East Berlin and decided that his holotype was an immature specimen. A fragment of a paratype shows the mature character of a rugose lower columellar shield. The type which is a dead specimen shows a hint of 4 or 5 spiral rows of yellowish brown spots, and a specimen, also dead, from the John Murray Expedition Station 110, shows about 24 mauve-brown, narrow stripes on the reflected outer lip. Fresh specimens bear 5 spiral rows of red-brown squares on the body whorl.

**Description**—Shell 48 to 65 mm. (about 2 to 2½ inches) in length, solid, evenly-ovate, and with numerous, flattish, spiral lirae which are separated by interstices of half their width. Color pale grayish white with 3 to 5 diffused reddish brown bands or rows of subdued yellowish brown spots. Nuclear whorls 3½, bulimoid, white and smooth. Post-nuclear whorls 5, the last bearing 24 to 27 flattish spiral cords of which the upper 2 or 3 may be slightly beaded. Suture simple and slightly impressed and ascending a little near the aperture. Spire convex-conic. Aperture ⅔ the total length of the shell, rather narrow. Outer lip thick, glossy, reflected, crossed by about 24 spiral teeth which continue weakly on the inside of the body whorl. Posterior edge of outer lip weakly crenulate and with 24 to 26 narrow, mauve-brown stripes. True umbilicus minutely open; false umbilicus usually sealed. Channel narrow and deep behind the siphonal canal. Parietal wall spirally corded, lightly glazed. Columellar shield strongly and unevenly pustuled. Inner lower columella edge with a high, gnarled or toothed, white ridge. Operculum unknown.

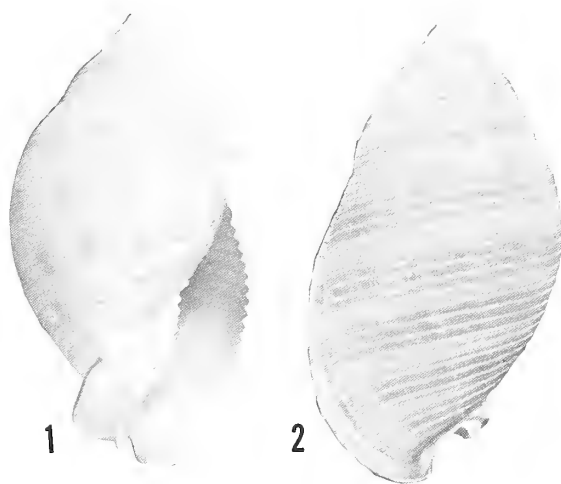


Plate 122. *Phalium (Semicassis) microstoma* (von Martens, 1903). Fig. 1, 100 meters, 40 miles east of Dar es Salaam, Tanzania. 57.8 mm. in length. Fig. 2, slender form, 200 meters depth. 58.3 mm.

**Measurements (mm.)—**

length	width	no. whorls	
65.5	40.1	9	large; off Pemba Island
52.0	38.5	7	holotype of <i>microstoma</i>
48.0	29.6	7	40 mi. E. of Dar-es-Salaam

**Synonymy—**

- 1903 *Cassis microstoma* von Martens, Wissenschaft, Ergebn. Deutschen Tiefsee-Exped., "Valdivia", vol. 7, pt. A, p. 112, pl. 3, fig. 12.  
 1935 *Phalium microstoma* (Martens), Bayer, Zoolog. Mededeel, Leiden, vol. 18, p. 103.

**Types**—The holotype and paratypes of *Cassis microstoma* are in the Zoological Museum in East Berlin (1962). The type locality is "Valdivia station 254, near the coast of Somalia, off Brava in 977 meters in depth on blue mud (S. Lat. 0° 29'; W. Long. 42° 47')."

**Records**—TANGANYIKA: 30 mi. off Dar-es-Salaam (6° 34' S; 30° 35' E), 404 meters, Valdivia Sta. 242 (Berlin Museum). Just west of Pemba Id. (5° 03' 42" S; 30° 15' 24" E), 329 meters, John Murray Exped., Sta. 110, 1934 (Brit. Mus.); just west of Pemba Id. (5° 38' 54" S; 39° 15' 42" E), 212 meters, John Murray Exped. Sta. 106, Jan. 12, 1934. A fragment only. (Brit. Mus.); about 40 miles east of Dar-es-Salaam (6° 51' S; 39° 54' E), 100 meters, Anton Bruun Sta. 9-422; about 41 miles east of Dar-es-Salaam, 200 meters, bottom temp. 13.93° C, Anton Bruun Sta. 9-423. SOMALIA: (type locality, see above); 250 mi. east of Mogadiscio (1° 49' N; 49° 29' E), 1134 meters, Valdivia Sta. 256; 20 mi. east of Chiambon (1° 40' S; 41° 47' E), 693 meters, Valdivia Sta. 251 (both Berlin Mus.).

**Fossil records**—None reported.





Plate 123. *Phalium* (*Semicassis*) *microstoma* (von Martens, 1903). Original figure of holotype. 977 meters depth, off Somalia, East Africa.

#### *Phalium sufflatum* (Tenison-Woods, 1877)

*Range*—Miocene-Pliocene of Victoria, Australia.

*Remarks*—This delicate inch-long *Semicassis* from the Miocene-Pliocene is quite possibly a progenitor of the Recent *semigranosum* (Lamarck) found now along the southern coasts of Australia and in Tasmania. Pritchard (1896, p. 106) stated that *transennum* Tate, 1889 is undoubtedly a synonym of *sufflatum*. A description of the latter is:

“Protoconch of two and a half smooth, depressed turns, gradually increasing in size from the initial portion, abruptly separated from the succeeding whorl. The cancellate ornament, so well developed on the body-whorl of the adult, commenced to form in the earliest part of the brephic stage. Spire elevated, subangulate at the shoulder; suture accompanied by a small, acute ridge; aperture oval-oblong, obtuse posteriorly, and rounded in front; outer margin thickened, reflected, and dentate within; columellar expansion smooth, forming a thin plate anteriorly; columella twisted, and having several irregular plications, with here and there a tubercle anteriorly. A characteristic feature of the shell is the fine cancellate ornament. Length, 29mm.; breadth, 17 mm.; length of aperture and canal, 19 mm.”

The type locality is “Eocene: Muddy Creek, Victoria”. Mrs. Joy Kerslake sent me a fossil specimen from Balcomb Bay, near Mornington, Victoria.

#### *Synonymy*—

- 1877 *Cassis sufflatus* Tenison-Woods, Papers Royal Soc. Tasmania for 1876, pp. 93, 94 (Table Cape).
- 1889 *Semicassis transenna* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 166, pl. 8, fig. 2 (Lower beds at Muddy Creek; blue clays at Schnapper Point; calciferous sandstones, River Murray Cliffs near Morgan; Table Cape).
- 1896 *Semicassis sufflatus* Tenison-Woods, Pritchard, Proc. Royal Soc. Victoria, vol. 8, new series, p. 106; 1897, Harris, Cat. Tertiary Mollusca, pt. 1, p. 199.
- 1958 *Semicassis* (*Antecephalium*) *sufflata* (Tenison-Woods), Ludbrook, Transactions Royal Society South Australia, vol. 81, p. 52 (Janjukian-Dry Creek Sands; Gippsland, Victoria and Adelaide, South Australia).

#### *Phalium mekranicum* (Vredenburg, 1925)

*Range*—Upper Miocene, Mekran Beds of Gwadar, Talar Mountains, India.

*Remarks*—The original specimens are poorly preserved but resemble low-spined, smoothish *P.* (*Semicassis*) *bisulcatum*. In length they vary from 28 to 36 mm. Vredenburg remarked that “this shell, like several other fossil forms, illustrates the difficulty of distinguishing, at times, between *Semicassis* and *Bezoardica* [*Phalium*].”

#### *Synonymy*—

- 1925 *Cassidea* (*Semicassis*) *mekranica* Vredenburg, Memoirs Geol. Survey India, vol. 50, pt. 1, p. 267, pl. 3, figs. 7-9 (Mekran beds: north of Talar Gorge, on the road from Kej to Gwadar, base of the sandstones constituting the Talar Mountains).

#### *Phalium oligocalanticum* (Vredenburg, 1925)

*Range*—Oligocene, Nari Beds in Sind, India.

*Remarks*—This 1½-inch (30-39 mm.), globular-ovoid species is characterized by numerous, fine, spiral, beautifully beaded threads on the last whorl. The top row of beads creates a crenulated suture. The columellar shield bears close-set, transverse ridges. Vredenburg gave a very lengthy description and likened this species to *Galeodea calantica* Deshayes from the Upper Eocene of the Paris region, which, however, is more coarsely noded and lacks the transverse *Semicassis*-like ridges on the columellar shield. The sculpturing of *oligocalantica* closely resembles that of the Recent *Galeodea leucodoma* Dall from Japan.

#### *Synonymy*—

- 1925 *Cassidea* (*Semicassis*) *oligocalantica* Vredenburg, Memoirs. Geol. Survey India, vol. 50, pt. 1, p. 263, pl. 3, figs. 3-5; pl. 4, fig. 5 (Nari of Bhagothoro Hill in Sind).

**Phalium sculptum J. de C. Sowerby, 1840**

(Pl. 124)

**Range**—Miocene Gaj of Kutch, northwest India.

**Remarks**—This small, 1¾-inch cassid has the shape of a somewhat compressed *P. (Semicassis) bisulcatum*. Vredenburg (1925, pp. 271-274) gave a lengthy description of the shell and allied it, erroneously I believe, to the typical *Phalium*. Because of the absence of a swelling and strong teeth on the central part of the outer lip and because Vredenburg's description of the nuclear whorls fits that of *Semicassis* rather than *Phalium* (*s.s.*), I am placing it near such species as *bisulcatum*. The shell lacks former varices, as do many other *Semicassis*. Vredenburg erroneously added Cossman's "*Bezoardica strigata* Gmelin" (1903, pl. 6, fig. 9) from the Pliocene of Karikal, India, to the synonymy of *sculptum*. Cossmann's is undoubtedly a broken specimen of *Phalium (Phalium) glaucum* Linné.

*P. sculptum* also resembles *P. exarata* Reeve from the Recent, but the latter lacks longitudinal threads on the siphonal fasciole.

**Synonymy**—

- 1840 *Cassis (Cypraeacassis) sculpta* J. de C. Sowerby, Trans. Geol. Soc. London, series 2, vol. 5, p. 329, pl. 26, fig. 21 and explanation to plates (Soomrow, Kutch, N.W. India).  
 1925 *Cassidea (Bezoardica) sculpta* Sowerby, Vredenburg, Memoirs Geol. Survey India, vol. 50, pt. 1, p. 271-274 (Gaj of Kutch; Rampur).



Plate 124. *Phalium (Semicassis) sculptum* (Sowerby, 1840). Lower Miocene, Gaj Beds, Kutch, India. Holotype, 43 mm. Brit. Mus. (Nat. Hist.) no. GG 3057 (photo courtesy of P. Nuttall).

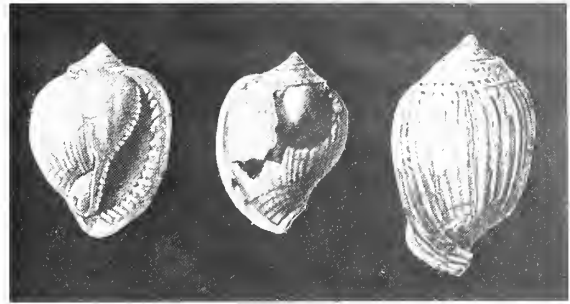


Plate 125. *Phalium (Semicassis) denseplicatum* (K. Martin, 1916). Lower Miocene, West Progo beds of Java, Indonesia, 35 mm. (from K. Martin, 1916, pl. 2, figs. 42, 42a, 43).

**Phalium denseplicatum (K. Martin, 1916)**

(Pl. 125)

**Range**—Lower Miocene; West Progo of Java, Indonesia.

**Remarks**—Although only ten specimens are known, this appears to be a quite distinct 35 mm.-long *Semicassis* characterized by well-developed axial riblets. The suture is bordered below by a well-beaded spiral cord, a feature rarely seen in *Semicassis*. K. Martin's figure 43 shows a shell somewhat resembling the *Cypraeacassis testiculus* complex, but Martin says the specimen was considerably misshaped in preservation. The numerous small teeth along the entire inner lip is an unusual feature.

**Synonymy**—

- 1916 *Cassis (Semicassis) denseplicata* K. Martin, Samml. Geol. Reichsmus. Leiden, Neue Folge, vol. 2, pt. 6, p. 243, pl. 2, figs. 42, 42a, 43 (Gunung Spolong and Kali Kemedjing, Lower Miocene, West Progo beds of Java).

**Phalium turricula Dall, 1909**

(Pl. 126)

**Range**—Upper Miocene and Lower Pliocene of Oregon.

**Remarks**—Schenck (1926, p. 79) remarks that "the 15 spirals on the body whorl, absence of intercalary threads, and large size [80 mm.] characterize this species." The ribs bear numerous, small, squarish nodules. Dall's original description reads:

"Shell large, moderately thick, with an unusually elevated spire, with five sculptured whorls and a smooth nucleus of about two and a half whorls; axial sculpture of (on the penultimate whorl about 20) faint, obscure, somewhat flexuous ridges, chiefly noticeable from the nodula-



Plate 126. *Phalium* (*Semicassis*) *turricula* Dall, 1909. Holotype. 80 mm. Tertiary of Oregon.

tions which occur when the raised spirals cross them; the ridges are almost wholly absent from the last half of the last whorl; faint incremental lines also occur; spiral sculpture of (between the suture 4, on the last whorl 15) narrow raised revolving ridges with much wider interspaces but no intercalary small threads; where the ridges cross the axial ridges they are more or less undulated and swollen, the peripheral ridge on the spire has these projections particularly marked; there is no spiral striation; the suture is wound on the fourth spiral and, when the latter is nodulous, is undulated more or less; the type specimen has two varices, which is exceptional in this group and may be an individual aberration; aperture longer than wide, the outer lip thickened and reflected, internally denticulate; body with a callus which is raised at its anterior margin; canal short, deep, strongly reflected, with a deep wide sulcus behind it; the outer lip is constricted just before forming the varix. Altitude, 80 mm.; maximum diameter, 50 mm."

#### *Synonymy* —

- 1909 *Phalium* (*Bezoardica*) *turricula* Dall, U. S. Geol. Surv. Prof. Paper, 59, p. 63, pl. 4, fig. 6 (Coos Bay, Oregon; holotype USNM no. 153898); 1926, Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 79, pl. 14, fig. 1; 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 410, pl. 81, fig. 3; pl. 101, fig. 4 (holotype re-figured).

### *Phalium* *egberti* Schenck, 1926

*Range* — Lowermost Oligocene, Olympic Peninsula, Washington State.

*Remarks* — Weaver (1942, p. 411) notes that "this moderately large [25.5 mm.] species differs from the other species of the genus in the Northwest in the presence of closely set spiral primary and secondary ribs which are crossed by fairly well-developed fine unequally spaced longitudinal ribs. Faintly developed nodes are present on the angulated part of the upper surface of the body whorl." Schenck's original description reads:

"Shell thick, mediumsize, globose, with acute spire about one-half height of body whorl. This ultimate whorl rounded, not sharply angulated. Callus smooth, thin, and quite adherent except anteriorly. Varices indistinct. Reflected anterior canal with deep sulcus behind siphonal fasciole. Sculpture: spire whorls marked by fairly distinct spiral threads crossed by faint growth striae. On body whorl spirals strap-like, distinct anteriorly but becoming progressively indistinct posteriorly; interspaces shallow; growth striae developing into fine threads on crossing spiral sulcations so as to give shell finely reticulated appearance. Halfway between the greatest convexity of body whorl and the suture is row of small nodes, with two other rows of incipient nodes anterior to first row. Dimensions: Type specimen, altitude 25.5 mm., greatest convexity 16 mm."

#### *Synonymy* —

- 1926 *Phalium* (*Bezoardica*) *egberti* Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 80, pl. 13, fig. 7 (Woodman Station, Discovery Bay, Olympic Peninsula, Wash.; holotype no. 79, Geol. Dept. Stanford Univ., L. S. J. U., loc. N. P. 148); 1942, Weaver, Univ. Washington Publ. Geol., vol. 5, p. 411, pl. 81, fig. 4 (holotype re-figured).

### *Phalium* *iani* Schenck, 1926

*Range* — Middle Oligocene, Willapa River Valley, Pacific Co., Washington.

*Remarks* — Although this species was placed in *Liracassis* (i.e. *Mauicassis*) by Moore (1963, p. 31), I am following Schenck's (1926) and Weaver's (1942) instincts and placing it in *Phalium*. It is obviously related to such other *Phalium* of the same region as *egberti* Schenck and *aequisulcatum* Dall. Although these *Phalium* have occasional varices and are very similar in shape and sculpture to several Recent *Semicassis*,



the parietal shields are poorly developed, perhaps because of immaturity or poor preservation.

Schenck's original description was: "Shell fairly thick, medium size, globose; acute spire half the height of body whorl; five whorls; appressed sutures; short, reflected canal; fairly distinct varices. Sculpture: Consists of broad, flat revolving lines (11 on body whorl) with well-defined equal interspaces in which there is one (sometimes two) intercalary thread; on upper part of body whorl longitudinal lines form two rows of low nodes, about 20; on early whorls, axial ridges appear to develop earlier than the nodes. Dimensions: Type specimen, altitude 30 mm. (part of canal lacking); greatest convexity 19.5 mm. Plate 13, figures 9, 10, 11, show variations in size." Weaver (1942, p. 411) added a note that "the adult forms of this species are smaller than the others from the Northwest. The species resembles somewhat *P. aquisulcatum* but possesses fewer and wider spiral ribs and has two spiral rows of tubercles on the upper surface of the body whorl and sometimes three rows on the penultimate."

#### Synonymy—

- 1926 *Phalium* (*Bezoardica*) *iani* Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 80, pl. 13, figs. 8-11 (near Menlo, Pacific Co., Wash.; holotype in Cal. Acad. Sci. 1747); 1931, Etherington, *ibid.*, vol. 20, p. 102; 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 411, pl. 81, fig. 5 (holotype re-figured).  
 1963 ?*Liracassis* *iani* Schenck, E. J. Moore, U. S. Geol. Surv. Prof. Paper, 419, p. 31 (Montesano formation, Miocene, Washington).

#### *Phalium aquisulcatum* Dall, 1909

*Range*—Upper Miocene and Lower Pliocene of Oregon and Washington States.

*Remarks*—Weaver (1942, p. 410) says that "this species may be distinguished from *P. turricula* Dall in its smaller size, the presence of the single intercalary thread, and in having 19 instead of 15 spiral ribs. The spire is proportionately lower than in *P. egberti* Schenck and it lacks the somewhat reticulated sculpture and slightly developed nodes on the body whorl of that species." Dall's original description reads:

"Shell of moderate size [45 to 60 mm.], solid, heavy, ovate, with about five whorls beside the (decollate) nucleus; suture distinct, not channeled; sculpture of (on the last whorl 19) even, flat, straplike, raised, subequal spirals, separated

by channeled, narrower equal sulci or interspaces most of which carry a single minute intercalary thread, which on the base is as a rule slightly nearer the posterior side of the channel in which it lies; there are faint traces of fine spiral striation, and the posterior four or five of the major spirals are somewhat beaded or granulated by axial sulci which do not appear in the channels; the varices except the terminal one are inconspicuous and irregular; two specimens, including the largest, show none; the figured specimen, which is smaller though better preserved, has indications of two besides the terminal varix; aperture longer than wide, subovate; outer lip reflected and thickened, internally dentate; body with a thin smooth callus (not in the figured specimen); canal deep, short, twisted, recurved, with a deep smooth sulcus behind it. Altitude of figured specimen, 45 mm.; of a larger but still immature individual (decollate), 60 mm.; maximum diameter, respectively, 30 and 39 mm."

#### Synonymy—

- 1909 *Phalium* (*Bezoardica*) *aquisulcatum* Dall, U.S. Geol. Surv. Prof. Paper, 59, p. 63, pl. 5, figs. 1, 4 (Coos Bay, Oregon; holotype, USNM no. 153896); 1926, Schenck, Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 16, p. 79, pl. 13, figs. 5, 6, 12-16; 1942, Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 409, pl. 81, fig. 2 (holotype re-figured) (Grays Harbor Co., Wash.).

#### *Phalium oregonense* (Dall, 1909)

*Range*—Middle Oligocene, Tunnel Point sandstone, Oregon and Washington.

*Remarks*—The fact that this species has the general shape and spiral ridges of some *Semicassis*, together with a short canal which is deeply excavated, twisted, more or less plicate, and has a deep channel behind it, leads me to place it among the *Phalium* (subgenus *Semicassis*) and not in *Galeodea* (as done by Weaver and by Durham) or *Liracassis* (i.e., *Maucassis*) by E. J. Moore (1963). Other species of *Phalium*, such as *egberti* Schenck and *iani* Schenck also occur in the Oligocene of the same general area. The strong spiral ribs occur in the Recent *Phalium whitworthi* Abbott of Western Australia, and I do not think that feature would justify erecting still another genus.

Dall's original description reads: "Shell thin, globose, strongly spirally sculptured, with about five whorls exclusive of the nucleus; earlier whorls with three or four, last whorl with about

11 major spiral ridges, squarish, often irregularly squarely nodulous, with wider channeled interspaces, smooth, or containing one or more smaller intercalary ridges; the posterior major spiral runs close to the suture, giving it a channeled effect; the spirals on the apical whorls are often reticulated by obscure axial riblets subnodulous at the intersections, but these disappear on the later whorls, though the major spirals often continue to show irregular nodulation; last whorl much the largest, terminating in the adult in a slightly reflected and thickened outer lip with obscure denticulations on its inner edge; canal short, deeply excavated, with a deep sulcus behind it, twisted and more or less plicate; a thin wash of callus on the body. Altitude of shell, 69 mm.; of last whorl, 60 mm.; maximum diameter 51 mm. Another specimen measures, respectively, 75, 64, and 53 mm."

Weaver (1942, pl. 81, fig. 1) illustrated a specimen, possibly immature, from a cut in the bank at Olympia Foundry, South Seattle, in a bluff along the east side of Duwamish Valley, King Co., Washington (Oligocene). E. J. Moore (1963, p. 30) asks if this might not be the Empire formation of the Pliocene.

#### *Synonymy* —

- 1909 *Eudolium oregonense* Dall, U.S. Geol. Surv. Prof. Paper, 59, pp. 71, 72, pl. 7, fig. 7 (Coos Bay, Oregon). Holotype, USNM 153895.  
 1942 *Galeodea oregonense* (Dall), Weaver, Univ. Wash. Publ. Geol., vol. 5, p. 409, pl. 81, fig. 1, pl. 101, fig. 12 (holotype re-figured).  
 1962 *Liracassis oregonensis* (Dall), E. J. Moore, U.S. Geol. Surv. Prof. Paper, 419, p. 30 (Pliocene? of Oregon).

#### *Phalium glabratum* (Dunker, 1852)

This species appears to be limited to the Western Pacific. It is characterized by a thin, lightweight but strong, glossy shell; by its elongated shape; by the rather narrow aperture which is bounded by a narrow but strong, smooth varix; by its narrow but deep umbilicus; and by the distinct, microscopic beading on the first 2 or 3 post-nuclear whorls. The species may be divided into three well-defined subspecies:

*glabratum glabratum* (Dunker, 1852)-limited to the central area of the species' distribution in the Philippines, Indonesia, and New Guinea. Left margin of columella shield only slightly indented; shell glossy white, with 7 or 8 prominent splotches of light-brown just below the suture, and with a pure white or yellowish varix. (Compare with *Casmaria ponderosa* forma *quadrata* (Link) which has no umbilicus nor beaded early whorls).

*glabratum angasi* (Iredale, 1927)-limited to the northern and eastern coasts of Australia. Left margin of columellar shield strongly indented in the area of the true umbilicus. Shell glossy translucent-cream with a suffusion of purplish tan on the dorsal sides of the whorls; subsutural blotches absent or very weak; varix white or yellowish.

*glabratum bulla* Habe, 1961-limited to the southern half of Japan to southeast China and Hawaii. Similar to *angasi*, but with the left margin of the columellar shield only slightly indented, and with 16 to 18 fine, purplish mauve stripes on the varix.



Plate 127. *Phalium (Semicassis) glabratum glabratum* (Dunker). Three specimens from the Moluccas, Indonesia.

Zool. Mus. Amsterdam, Netherlands. Shell at right is 47.7 mm. in length.

**Phalium glabratum subspecies  
glabratum (Dunker, 1852)**

(Pl. 127)

**Range**—Southwest Pacific in the Philippines, Indonesia, and Melanesia.

**Remarks**—The typical subspecies is very rare. I have seen only seven specimens in American and European collections. It is distinguished from its neighboring subspecies in Japan and Australia by the bright, yellow-brown blotches just below the suture and by the great sharpness of the minute prickles on the inner edge of the outer lip. It may be distinguished from *Casmaria ponderosa* Gmelin, forma *quadrata* (Link) by its narrow true umbilicus and slit-like false umbilicus and by its microscopically beaded early post-nuclear whorls.

The ship "Albatross" dredged a broken specimen at station 5311 in 88 fathoms, off Pratas Island, 200 miles southeast of Hong Kong which somewhat intergrades between *glabratum* and the Japanese subspecies, *bulla* Habe. I have provisionally identified it as a *bulla*. A specimen from Kei Island in the Banda Sea, north of Australia, has a quite well indented left columellar edge which suggests an intergrade with Darwin, N.W. Australia, specimens. A Darwin specimen of the subspecies *angasi* (Iredale) has subdued subsutural blotches resembling those of typical *glabratum*. For these reasons I consider *angasi* and *bulla* to be geographical subspecies of the centrally located *glabratum*.

**Habitat**—Rare and dredged by Th. Mortensen (station 30) in 40 meters on a sand bottom (off Kei Island, Banda Sea).

**Description**—Adult shell 33 to 61 mm. (about 1-1/4 to 2-1/2 inches) in length, thin-shelled, light in weight, but strong; elongated; glossy enamel white with 7 or 8 rectangular blotches of yellow-brown just below the suture; with a small, deep true umbilicus and a narrow, slit-like false umbilicus. Whorls 7 to 8. Nuclear whorls bulimoid, 3, glossy, white, smooth; the first post-nuclear whorl bears 6 or 7 spiral, beaded threads, but in succeeding whorls these spiral lines disappear except for a single weakly beaded thread just below the finely impressed suture. Body whorl glossy, smooth and white. There is a blush of mauve on the dorsal side of penultimate whorl. The entire apex bears only 8 to 13 subsutural squarish, yellow-brown blotches. Aperture relatively narrow. Varix narrow, strong, slightly

recurved to form a gutter behind, white to yellowish, and with about 14 to 17 spiral, fine teeth on the inner edge which terminate as sharp, minute prickles. Columellar shield poorly developed, with numerous, spiral wrinkles. Left edge of columellar shield slightly thickened and slightly sinuate or indented. True umbilicus narrow, round, very deep; false umbilicus slit-like, deep, and bordered on the lower, inner edge by a sharp, pointed projection of the columella. Interior of aperture white to tan-cream. Base of shell with 2 to 4 weak or strong spiral, incised lines. Soft parts and operculum unknown.

**Measurements (mm.)—**

length	width	no. whorls	
61.0+	35.4	6+	large; near Cebu Id., Philippines
52.1	30.0	7+	no locality; ANSP
47.7	29.5	8	Moluccas
33.8	21.0	8	small; Kei-Doelah Id., Banda Sea

**Synonymy—**

1852 *Cassis glabrata* Dunker, Zeitschrift für Malakozool., 9th year, p. 62 (Zanzibar); 1858, Dunker's Novitates Conchologicae, series 2, vol. 1, p. 35, pl. 11, figs. 1, 2 (eastern Africa). [non *glabrata* Meuschen, 1787, which, however, is non-binomial].

**Types**—I was unable to locate Dunker's type in the Berlin Museum, the Senckenburg Museum, or the British Museum. Dunker's figured specimen, also not located, measured 68 x 37 mm. The type locality, according to the sea captain, Albert Rodatz, who brought it to Dunker, is "Zanzibar", but I question its accuracy.

**Records**—PHILIPPINES: near Cebu Id. (E. Zambo, legit. 1961; T. Montgomery); 18 fms., off Tawi Tawi, Albatross Sta. 5164 (USNM). INDONESIA: Molucca Islands (Zoolog. Mus. Amsterdam); 1 mi. off the northwest end of Kei-Doelah Id., Kei Ids., S.E. Banda Sea; Th. Mortensen station 30, trawled in 40 meters on sand and shell bottom associated with numerous crinoids, sponges and gorgonians (Zoolog. Mus. Copenhagen). [Salmon's 1948, p. 163, record of *glabratum* from Obock, French Somalia, is based upon a smooth specimen of *Casmaria ponderosa* subspecies *bicolor* Dautzenberg.]

**Fossil records**—None recorded.

**Phalium glabratum subspecies  
angasi (Iredale, 1927)**

(Pl. 8, fig. 9; pl. 128)

**Range**—Northwestern Australia to Queensland and south to northern New South Wales, Australia.

**Remarks**—The comparative diagnostic characters of this Australian subspecies are given above. The exposed true umbilicus, the rather large false umbilicus, and the persistence of the beaded microscopic sculpturing on the first three





Plate 128. *Phalium* (*Semicassis*) *glabratum* subspecies *angasi* (Iredale, 1927). Figs. 1, 2, holotype of *angasi* Iredale, 52 mm. Figs. 3, 4, holotype of *knighti* (Thornley, 1954), 40.0 mm. (Both in the Australian Museum; photo courtesy of D. F. McMichael).

post-nuclear whorls readily distinguished it from typical *glabrata glabrata*. The surface of the body whorl is weakly malleated as in the Japanese subspecies *bullata*. *S. glabrata angasi* is moderately common in 10 to 20 fathoms off shore. The indented left edge of the columellar shield is present in two other distantly related Australian cassids which may be interpreted as a "regional" character.

Thornley's *knighti*, originally described as a subspecies of "*Xenogalea angasi*" is merely a minor variant, being pale pinkish, more rounded and less sculptured.

**Description**—Adult shell 33 to 58 mm. (about 1-1/4 to 2-1/4 inches) in length, thin-shelled, light in weight, but strong; elongated; glossy, with a slightly malleated surface, translucent white, tan or blotched with purplish tan; rarely with a few faint, small rectangular, brownish, subsutural blotches; with a deep, small true umbilicus and a false umbilicus of about the same size. Whorls 8. Nuclear whorls 3, bulimoid, glossy smooth and opaque-white. First 3 post-nuclear

whorls with 5 to 7 beaded spiral threads. In later whorls, the beading disappears, but 1 to 3 faint spiral lines may persist in the last whorl. Body whorl glistening and smoothish. There is a blush of mauve-tan on the dorsal side of the body and penultimate whorls. Aperture relatively narrow. Varix narrow, strong, slightly recurved to form a gutter behind, white to yellowish. Inner side of varix with about 15 to 18 small, moderately sharp prickles. Rarely with a former varix. Columellar shield poorly developed and with numerous, fine, spiral wrinkles. Left edge of columella strongly indented in the region of the true umbilicus. Interior of aperture white or light-tan. Base of shell with 3 to 5 weak, spiral, incised lines. Soft parts and operculum unknown.

*Measurements* (mm.)—

		no.	
length	width	whorls	
57.5	33.0	8	large; off Brunswick Heads, N.S.W.
52.0	33.1	7	holotype of <i>angasi</i> Iredale
40.0	25.0	6.5	holotype of <i>knighti</i> Thornley
38.0	24.0	6	holotype of <i>denisi</i> Salmon
33.1	20.7	7	small; off Darwin, N.W. Australia

*Synonymy*—

- 1911 *Cassidea angasi* Brazier, Shirley, Proc. Royal Soc. Queensland, vol. 23, p. 98 (Caloundra, Queensland). *Nomen nudum*. [not seen].  
 1927 *Xenogalea angasi* Iredale, Records Australian Museum, vol. 15, p. 350, pl. 32, fig. 15 (Moreton Bay [Brisbane], Queensland [Australia]).  
 1948 *Phalium denisi* Salmon, Jour. de Conchyl., Paris, vol. 88, p. 161, text figs. on p. 162 (no locality).  
 1954 *Xenogalea angasi knighti* Thornley, Proc. Royal Zool. Soc. New South Wales for 1952-53, p. 33, pl. 1, fig. 6 (Sinclair Bay, Gloucester Id., near Bowen, Queensland, Australia).

**Habitat**—Thornley (1954, p. 33) reports that this subspecies burrows in 4 to 6 inches of sand on sandy flats exposed to strong tidal currents (near Bowen, Queensland). It also occurs at depths of 10 to 35 fathoms on sandy bottoms.

**Types**—The type locality of *angasi* given by Iredale is Moreton Bay, Brisbane, Queensland, Australia. The holotype is in the Australian Museum in Sydney, no. C 2485. The holotype of Thornley's *knighti* is also in the Sydney Museum, no. C 63955. The holotype of Salmon's *denisi* is in the Museum d'Histoire Naturelle in Paris.

**Records**—(all Australia). NORTHERN TERRITORY: Arafura Sea, off Darwin (A. R. Cahn, coll'n., ANSP); 15-20 fms., 100 mi. N.W. of Darwin (Vernon Wells, ANSP). QUEENSLAND: Cowlshaw Reef (B. Kaspiew, ANSP); Bowen, Cape Gloucester (Aust. Mus.); 20 fms., Keppel Bay (Tony Marsh, ANSP); 10 fms., Hervey Bay (Aust. Mus. and ANSP); 35 fms., Tin Can Bay, S.E. of Fraser Id. (T. A. Garrard, ANSP); Coloundra (ex Shirley, 1908, Nat. Mus. Vict.); Bowen (Nat. Mus. Vict.); Noosa Heads (B. Bardwell, Nat. Mus. Vict.). NEW

SOUTH WALES: Tweed Heads (J. Kerslake, ANSP); Ballina (Aust. Mus.); 12 fms., off Evans Head (T. Hartley, ANSP); 18 fms., off Brunswick Heads (H. Bienke, ANSP); off Macleay River (Aust. Mus.).

*Fossil records*—None reported.



Plate 129. *Phalium (Semicassis) glabratum* subspecies *bullae* (Habe, 1961). Sagami Bay, Honshu, Japan. 53 mm.

*Phalium glabratum* subspecies  
*bullae* (Habe, 1961)

(Pl. 8, figs. 7, 8; pl. 129)

*Range*—Off the southern coasts of Japan to off southeast China; and Hawaii.

*Remarks*—The northern subspecies *glabratum bullae* Habe is not uncommonly trawled at depths of about 100 fathoms off the southeast coasts of southern Honshu and Shikoku Islands of Japan. The "Albatross" dredged a specimen in 88 fathoms, 200 miles southeast of Hong Kong, China, and it is probable that it occurs in the intervening areas. The shells are relatively fragile and translucent like those of the Australian subspecies, but differ in lacking the strong indentation of the left edge of the columellar shield and in having about two dozen, narrow, mauve streaks on the last varix. A former varix is sometimes present on the penultimate whorl.

The name "*Cassis tenuis* Hirase" used on labels by Japanese shell dealers is evidently a *nomen nudum*. Kuroda (Venus, vol. 17, no. 1, p. 35, 1952) in a footnote gave a brief descriptive key of Japanese cassids, without generic names, and introduced the names *obscurum* and *bullae*. Both names refer to the Japanese subspecies but are nomenclatorially invalid. The first validation of *bullae* occurs in Habe's 1961 "Coloured Illustrations of the Shells of Japan (II)".

*Description*—Adult shell 40 to 53 mm. (about 1½ to 2 inches) in length, similar to *glabratum angasi*, but with 12 to 25 fine, spiral, mauve stripes on the varix, with the left edge of the columellar shield only slightly sinuate (instead of well-indented), and with a proportionately smaller true and false umbilicus. Upper parietal wall in the posterior area of the aperture bears a clump of 3 to 5 very short, elongate, raised pustules, as in *angasi*. Operculum unknown.

*Measurements (mm.)*—

length	width	no. whorls	
53.1	32.6	8	large; Sagami Bay, Honshu Id.
48.2	28.0	8	off Tosa, Shikoku Id.
44.9	27.0	8	off Pratas Id., S.W. China Sea
39.2	24.6	8	small; off Tosa, Shikoku Id.

*Synonymy*—

- 1931 *Phalium (Bezoardica) tenuis* Hirase, Yokoyama, Cat. Marine, Freshwater and Land Shells of Japan, Imperial Geol. Survey Japan, Tokyo, p. 36 [*nomen nudum*]  
[1952 *obscurum* and *bullae*, Kuroda, Venus, vol. 17, no. 1, p. 35, footnote; species names only; invalid].  
1961 *Semicassis bullae* "Kuroda" Habe, Coloured Illustrations of the Shells of Japan, Osaka, vol. 2, p. 44, pl. 21, fig. 5 (Tosa, Japan, 50-100 fms.); 1961 Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Semicassis* plate 2, fig. 8 (Kumano-Nada).  
1961 *Semicassis obscurum* "Kuroda" Habe, loc. cit., p. 44, pl. 21, fig. 6 (Japan, 50-100 fms.); 1961, Oyama, The Molluscan Shells, Resources Exploitation Institute, vol. 5, *Semicassis* plate 2, figs. 6, 7 (Tosa).

*Types*—The type locality is Tosa, Shikoku Id., Japan, 50-100 fms. I cannot locate the type of either *bullae* or *obscurum*.

*Records*—JAPAN: HONSHU: Sagami Bay; Ise Bay, Mieken. SHIKOKU: Tosa, 100 fms. (all A. R. Cahn coll'n., ANSP). CHINA: 200 mi. S.E. of Hong Kong, off Pratas Id., 88 fms., "Albatross" Sta. 5311 (USNM). HAWAIIAN IDS.: 100 to 200 fms., mud, off Waikiki, Oahu Id., Pele Expedition, 1963 and 1964 (BPBM); 30 fms., live, off Keehi Lagoon, Oahu Id., C. S. Weaver, Sept. 1959.

*Phalium semigranulosum* (Lamarck, 1822)

(Pl. 8, figs. 1, 2; pls. 130-131)

*Range*—Tasmania and the southern coast of Australia.

*Remarks*—This is a common and well-known species of southern Australia which is characterized by the strongly beaded upper third of each whorl, by its chalky, whitish to pinkish coloration, and by its sealed false umbilicus. The parietal shield is very poorly developed and the

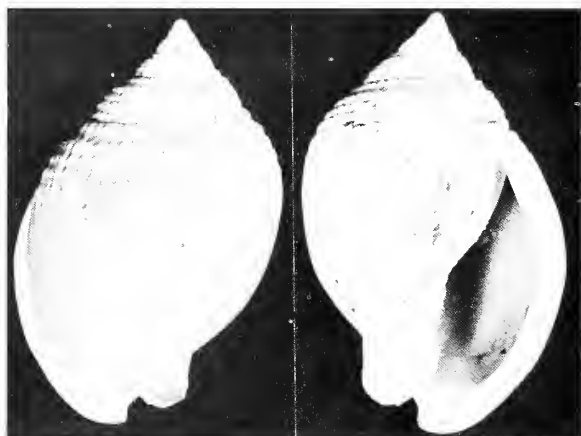


Plate 130. *Phalium* (*Semicassis*) *semigranosum* (Lamarck, 1822). Holotype. 48 mm. in length. [South Australia]. Mus. Geneva.

columella weakly lirate only within the aperture. I consider *Antephalium* of dubious subgeneric value.

**Habitat**—Moderately common on sand bottoms from a foot below low tide to depths of 15 to 200 fathoms. "Located on sandbanks, the animals are extremely active, preying on bivalve molluscs; excellent living examples have been obtained during night collecting at Portsea, while cast-up specimens are not uncommon at many points on the Victorian coast." (MacPherson and Gabriel, 1962, p. 146).

**Description**—Adult shell 29 to 600 mm. (about 1-1/8 to 2-1/2 inches) in length, solid, somewhat elongated, beaded on the upper third of the whorls, with a sealed-over true umbilicus, without a false umbilicus, and colored a uniform pastel pinkish tan or cream white. Whorls 6 to 8. Nuclear whorls 2-1/2, bulimoid, smooth, opaque white, tan or purplish. Post-nuclear whorls with 5 or 6 spiral rows of fine, evenly-spaced, rounded beads located on the upper third of the whorls. One row of beads borders the suture below, and below that is a relatively wide, slightly concave, shallow gutter bearing only axial wrinkles or growth lines. Aperture relatively narrow, the interior light-tan to brownish. Parietal wall with a slight glaze covering a dozen, weak, spiral incised lines. At the upper end of the aperture the parietal wall bears 3 to 5 obliquely-placed, raised, smooth, whitish plicae which may be fused into a small mound. Columellar shield poorly developed, glossy-white, bearing about 9 short, spiral wrinkles within, and with its smooth, rounded left edge entirely or partially sealing the true umbilicus.

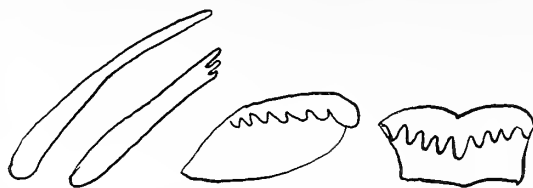


Plate 131. *Phalium semigranosum* (Lamarck). Radula. Modified to a different view from Cotton, 1945, p. 169.

Former varices usually absent. Last varix narrow, strong, smooth, cream-colored, and slightly recurved. Base of shell with a dozen spiral threads or incised lines. Operculum corneous, elongate, fan-shaped, brownish and with weak growth lines. Rachidian with 10 cusps; lateral with 8, inner marginal with 4, outer marginal simple, according to Cotton, 1945, p. 169.

#### Measurements (mm.)—

length	width	no. whorls	
60.6	39.0	7	large; Portsea, Victoria
52.6	33.0	7	average; Hobart, Tasmania
48.0	30.9	7	Lamarck's holotype
29.0	18.0	6	small, Western Australia

#### Synonymy—

- 1822 *Cassis semigranosa* Lamarck, Anim. sans Vert., vol. 7, p. 228, no. 23 (Nouvelle-Hollande); 1824, Dubois, Epitome Lamarck's. . . Testacea, p. 253.  
 1828 *Buccinum semigranosum* Wood, Index Testaceologicus, Supplement, p. 11. pl. 4, fig. 2.  
 1828 *Cassis semigranosa* Wood, loc. cit., p. 33, pl. 4, fig. 2.  
 1840 *Cassidea semigranosa* Lamarck, Swainson, Treatise on Malacology, London, p. 299.  
 1853 *Semicassis semigranosa* Lam., H. and A. Adams, Genera of Recent Mollusca, London, vol. 1, p. 216.  
 1857 *Cassis semigranosa* Wood, Küster, Syst. Conchylien-Cabinet, ed. 2, vol. 3, pt. 1 b, p. 24, pl. 44, figs. 6, 7; 1885, Tryon, Manual of Conch., Phila., vol. 8, p. 275.  
 1886 *Cassis semigranosa* Lam., Brazier, Trans. Royal Soc. South Australia for 1886, reprint p. 8 (long synonymy).  
 1945 *Antephalium semigranosum* (Lamarck), Cotton, Trans. Royal Soc. South Australia, vol. 69, no. 1, p. 169, text fig. of radula and operculum; 1962, MacPherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 146, fig. 174.

**Types**—Lamarck's holotype is in the Lamarck collection in the Museum of Natural History of Geneva, Switzerland. The type locality is "Nouvelle-Hollande". We further restrict the type locality to Hobart, Tasmania.

**Nomenclature**—This is one of the few cassids described in the early nineteenth century which has no synonyms. As Brazier pointed out in 1886, both Küster and Tryon were in error in attributing the authorship of *semigranosum* to Wood.





Plate 132. Geographical distribution of *Phalium (Semicassis) semigranosum* (Lamarek).

**Records**—(all Australia) TASMANIA: Hobart; Swansea; Stanley; 20 fms., in d'Entrecasteux Channel, T. A. Garrard; Frederick Henry Bay, G. Pridmore, 1967. (all ANSP); Bridport, Dorset (MCZ). VICTORIA: Portsea; Pewhaven; Western Port; Lake Entrance (all Nat. Mus. Vict.); Wilson's Promontory; San Remo, near Melbourne (both ANSP). SOUTH AUSTRALIA: Encounter Bay (ANSP); Middleton; Aldinga Bay (both Nat. Mus. Vict.); Port Willunga (MCZ); 15 fms., Yankalilla Bay; Pondolowie Bay; Lacepede Bay; 20 fms., Newland Head; off Beachport in 100, 110, 150 and 200 fms., 55 and 62 fms., off Cape Borda; 90 and 130 fms., off Cape Jaffa; 15 to 20 fms., off St. Francis Island (all B. C. Cotton, 1945, p. 169). WESTERN AUSTRALIA: Cheyene Beach, 50 mi. east of Albany (B. R. Wilson, West. Aust. Mus.); Leighton Beach (West. Aust. Mus.); 12 and 35 fms. in King George Sound; 35 fms., off Hopetown; Bunbury (B. C. Cotton, 1945, p. 169).

[records from New Zealand and South Africa are probably erroneous].

**Fossil records**—None reported.

### ***Phalium muelleri* (Tate, 1889)**

(Pl. 133)

**Range**—Pliocene of South Australia and Muddy Creek, Victoria, Australia.

**Remarks**—I am inclined to agree with Ludbrook (1958) that this species is close to *semigranosum*. The original description reads:

"Shell rather thin, globosely inflated; spire short, ending in a small pullus [nucleus] of one and a half, smooth, slightly swollen whorls.

"Whorls four, excepting pullus, separated by an impressed suture, roundly angled medially, spirally ribbed; the posterior whorls with about four spiral ribs, tessellated by transverse threads; penultimate whorl with a stout medial ridge, two behind, one at the posterior suture, and two or

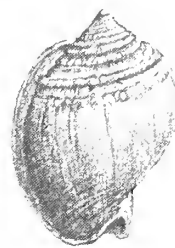


Plate 133. *Phalium (Semicassis) muelleri* (Tate, 1889). Type from the Upper Beds at Muddy Creek, Victoria, Australia. Pliocene. Length: 25 mm.

three in front. The ribs are rounded, unequally disposed, incised by rather distant oblique threads.

"Last whorl ventricose, with a round shoulder, posterior to which are five spiral ribs, the medial one the strongest, the posterior one margining the suture; the ribs are crossed by sharp threads which crenulate them, but on the middle of the whorl are obsolete or continued as striae; base with a few encircling depressed ribs.

"Aperture ovately lunate; outer lip plain, reflected; columella nearly straight, medially thickened, twisted and obliquely truncated at the end, with about ten slender revolving plaits, expanded over the umbilical region. Length, 25; breadth, 20; length of aperture, 18."

### **Synonymy**—

1889 *Semicassis muelleri* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 167, pl. 7, fig. 9 (Upper beds at Muddy Creek); 1896, Harris, Cat. Tertiary Mollusca, pt. 1, p. 199.

1943 *Antiphalium* [sic] *mulleri* (Tate), Crespín, Mineral Resources Survey Bull. 9, p. 95.

1958 *Semicassis (Antephalium) muelleri* Tate, Ludbrook, Transactions Royal Soc. South Australia, vol. 81, p. 52, pl. 2. (Kalimnan—Dry Creek Sands; Gippsland, Victoria; Adelaide, South Australia.

### ***Phalium adcocki* (Sowerby, 1896)**

(Pl. 134)

**Range**—Known only from the southern coast of Australia.

**Remarks**—This small but very attractive cassid has been collected on very few occasions. Less than a dozen specimens are known, one of these coming from a depth of 100 fathoms. Mr. George Pattison of South Australia has found them alive on reefs in St. Vincent Gulf. It is readily recognized by its solid shell, by the 6 spiral rows of very small, bright, red-brown spots on the body

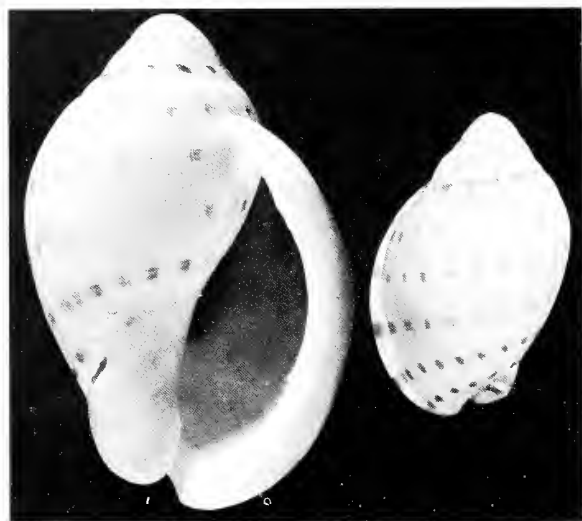


Plate 134. *Phalium (Semicassis) adcocki* (Sowerby, 1896). Yankalilla Bay, South Australia. A beach-worn specimen. American Museum Natural History no. 87744. 25.5 mm. in length.

whorl and by the axial, beaded plicae or wrinkles on the shoulders. The species shows no very close morphological relationships with other Australian cassids, although the Recent *semigranosum* (Lamarck) and the fossil *transennum* (Tate) have some features in common with it. Below, I am paraphrasing most of Iredale's excellent re-description:

**Description**—Adult shell 25 to 44 mm. (about 1 to 1¾ inches) in length, solid, regularly oval, white with 6 rows of very small spots of red-brown, and sculptured with strong axial plicae and weak spiral lines. Whorls 5; nuclear whorls white and smoothish. Adult whorls 3 to 4, the earlier ones spirally lirate and crossed by strong slanting axial threads or plicae which form a reticulation on the upper third of the whorls. Last whorl with 20 to 25 short axial, somewhat beaded plicae or wrinkles. Below are 18 to 20 spiral threads. Coloration pure-white, marked with spiral rows of small, bright red-brown spots, 6 rows on the body whorl, 20 spots to a row. Varix strong, smooth, white, with 5 spots, and weakly dentate at the anterior inner region. Parietal shield is merely a thin glaze. Columellar shield thick, rounded, sealing the umbilicus, and on the lower half with numerous, weak, spiral wrinkles. Siphonal canal short, tipped with red-brown, and bounded posteriorly by a narrow, rather deep gutter. False umbilicus absent.

#### Measurements (mm.)—

length	width	no. whorls	
28.0	17.0	6	holotype, fide Sowerby, 1896
25.5	17.0	5	Yankalilla Bay, S. Australia
24.6	16.5	6	South Australia; Nat. Mus. Vict.

#### Synonymy—

- 1896 *Cassid adcocki* Sowerby, Proc. Malacological Soc. London, vol. 2, p. 14, text fig. (Yankalilla Bay, South Australia); 1912, Gatliff and Gabriel, Proc. Royal Soc. Victoria, new series, vol. 25, p. 170.  
 1912 *Cassidea adcocki* Sowerby, Verco, Trans. Royal Soc. South Australia, vol. 36, p. 217; 1916, Hedley, Jour. Royal Soc. Western Australia, vol. 1, p. 47.  
 1927 *Antephalium adcocki* Sowerby III, Iredale, Records Australian Mus., vol. 15, p. 352; 1954, Cotton, Malacological Section, Royal Soc. South Australia, no. 4, p. 2, pl. 1, fig. 18; 1962, MacPherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 147.

**Types**—The type locality is Yankalilla Bay, South Australia, Australia. I have been unable to find the type which may have been in Mr. D. J. Adcock's collection.

**Records**—(all Australia) VICTORIA: Bass Strait (Gatliff and Gabriel, 1912, p. 170). SOUTH AUSTRALIA: (Gatliff coll'n., Nat. Mus. Vict.); "The Gorge", Yankalilla Bay (R. F. Leane, Amer. Mus. Nat. Hist.); Marion Reef; Normanville Reef; Aldinga Beach; Kangaroo Id., Port Victoria (all George Pattison, *in litt.*). WESTERN AUSTRALIA: 90 miles west of Eucla, Great Australian Bight, 100 fms. (Verco, 1912, p. 217).

**Fossil records**—None reported.

#### *Phalium sinuosum* (Verco, 1904)

(Pl. 135)

**Range**—Off South Australia to Western Australia.

**Remarks**—This inch-long, moderately thin-shelled cassid somewhat resembles a dwarfed *P. bisulcatum* (Schubert and Wagner), but it is characterized by its more elongated shape, the pinched-in outer lip and the weak columellar shield. The color spots are fewer, larger and more subdued than those of *P. adcocki*. Verco in 1904, with a series of 22 individuals before him, recognized that this species varies considerably in shape and color pattern. He mentioned a color variety A which was slightly narrower and which had the spotting fused into wavy, axial bands. Cotton and Godfrey in 1931 gave this form the name *angustatum*, and in 1945 and 1954 Cotton maintained it as a full species. We believe, however, that this taxon is merely a *forma*, and is well within the varietal limits of the species.

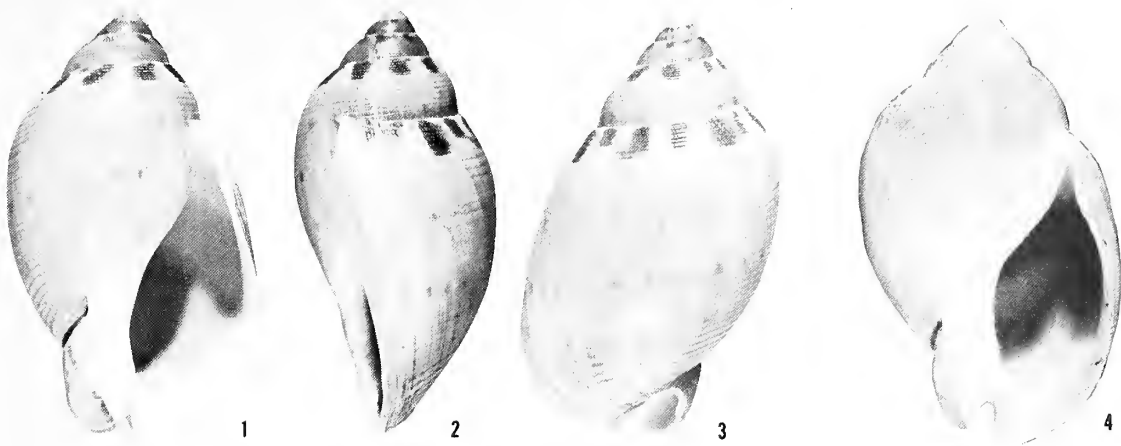


Plate 135. *Phalium (Semicassis) sinuosum* (Verco, 1904). Figs. 1-3, 10 fathoms off Binningup, 90 miles south of Fremantle, Western Australia. E. Nickels, collector, 1964. 27.1

The species is rare in collections, although Verco dredged 22 individuals in the Backstairs Passage of South Australia.

**Description**—Adult shell 17 to 27 mm. (about 1 inch) in length, thin-shelled, moderately strong, oval-elongate, microscopically and spirally striate, cream with sparse buff spotting or wavy bands. Whorls 5 to 6. Nuclear whorls 2, bulboid, smooth, opaque-white. Post-nuclear whorls with 10 to 13 microscopic threads which are crossed by fine, axial growth lines. On the body whorl the threads become flattened, especially on the middle of the whorl. Suture fine and bordered below by a finely beaded thread. Aperture constricted at the posterior third by the in-turning of the slightly thickened outer lip. Varix minute. Inside of outer lip weakly dentate. Parietal shield merely a weak glaze. Columellar shield white, poorly developed and with about a dozen fine, spiral wrinkles. True umbilicus almost completely sealed. False umbilicus at the base of the columella is small, deep and slit-like. Siphonal canal short. Color of shell cream to whitish with 5 spiral rows of subdued, squarish, relatively large brownish yellow spots which, in some specimens, may be elongated and merged to form oblique axial flames or bars. In some specimens, color blotches are limited to a series just below the suture. In living specimens the background tint of the shell is light pinkish brown, deeper on the nucleus and early post-nuclear whorls. Spots in spiral rows vary from 7 to 15 per whorl. Siphonal gutter narrow and shallow.

mm. Fig. 4, holotype of *Cassidaria sinuosa* Verco, 1904. Investigator Strait, South Australia. South Australian Museum. 24.6 mm.

“Radula with a rachidian with 6 small cusps on each side of a large central cusp; lateral tooth with 13 cusps; marginals long, slender and simple”. (Verco, 1904).

#### Measurements (mm.)—

length	width	no. whorls	
27.5	—	—	largest, fide Verco, 1904
27.2	15.0	6.0	Western Australia
24.6	15.5	6.0	holotype, D.13477, of <i>sinuosa</i> Verco
19.6	11.4	5.0	holotype of <i>angustatum</i> C. and G.
19	11	—	paratype, fide Verco, 1904
17.2	11.9	5	South Australia; Nat. Mus. Vict.

#### Synonymy—

- 1904 *Cassidea sinuosa* Verco, Trans. and Proc. Royal Soc. South Australia, vol. 28, p. 141, pl. 26, figs. 7-10, a-c (Investigator Strait, Backstairs Passage, South Australia).
- 1922 *Phalium sinuosum* Verco, Gatliff and Gabriel, Proc. Royal Soc. Victoria, new series, vol. 34, p. 143 (May, 1922).
- 1927 *Antecephalum sinuosum* (Verco), Iredale, Records Australian Museum, vol. 15, p. 353; 1931, Cotton and Godfrey, South Australian Naturalist, vol. 13, no. 1, p. 17; 1954, Cotton, Mal. Sect., Royal Soc. South Australia, no. 4, p. 2, fig. 19; 1962, MacPherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 147.
- 1931 *Antecephalum sinuosum angustatum* Cotton and Godfrey, South Australian Naturalist, vol. 13, no. 1, p. 17, pl. 2, fig. 5 (Backstairs Passage, 20 fms.).
- 1945 *Antecephalum angustatum* Cott. and Godf., Cotton, Trans. Royal Soc. South Australia, vol. 69, p. 251; 1954, Cotton, Mal. Sect., Royal Soc. South Australia, no. 4, p. 2, fig. 20.

**Types**—The type locality for *sinuosa* is “dredged in Investigator Strait, Backstairs Pas-



sage." The type is in the South Australian Museum, no. D.13477. The type locality for *angustatum* is also "Backstairs Passage", in 20 fathoms. The holotype is in the South Australian Museum no. D 10171, and was kindly loaned to me for photographing.

*Records*—(all Australia). VICTORIA: "taken off cable to

Tasmania, Bass Strait" (Gatliff and Gabriel, 1922, p. 143); 20-25 fms., off Lakes Entrance (Macpherson and Gabriel, 1962, p. 147). SOUTH AUSTRALIA: 40 fms., off Willoughley, Kangaroo Id., 1928 (George Pattison, *in litt.*, 1962); off Point Marsden, Kangaroo Id. in 15, 16, 17, 19 and 20 fms. (Verco, 1904, p. 141); Backstairs Passage (Verco, 1904, p. 141 and Cotton and Godfrey, 1931, p. 17); (Nat. Mus. Vict., Gatliff coll'n.); Beachport (Cotton and Godfrey, 1931, p. 17). WESTERN AUSTRALIA: 10-12 fms., 1 mile offshore, Binningup, 90 miles south of Freemantle (E. Nickels, coll.).

*Fossil records*—None reported.

[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]

**Phalium saburon (Bruguère, 1792)**

(Pl. 12, figs. 16-19; pls. 136-138)

**Range**—Mediterranean and northward to the Bay of Biscayne, France, and southward to Accra, Ghana, Africa; Azores.

**Remarks**—This moderately common Eastern Pacific species is characterized by its rather thick shell, globular shape, and by the numerous, fine, incised spiral lines on the body whorl. The columellar shield is mostly smooth, except for a few irregular, short lirae on the lower inner area. The columella bears from 5 to 8 irregularly-sized spiral plicae. Unlike the other Mediterranean cassid, *undulatum* Gmelin, *saburon* has a closed false umbilicus. The color of the shell is whitish with five diffused spiral bands or rows of yellowish brown spots. In some localities the shells may become covered with a dark black-brown stain. In length, the shell varies from 40 to 60 mm. (about 1-1/2 to 2-3/4 inches). The fan-shaped operculum is brown, with fine concentric growth lines and feeble, wide radial rays.

This species and its fossil progenitors have been on the south European scene since the Miocene. *P. craticulatum* (Euthyme, 1885) [*africanum* Fulton, 1930] is probably a remnant which is now isolated in South Africa. Records for *saburon* in the early literature referring to the Indo-Pacific were doubtlessly based upon specimens of *bisulcatum* (Schubert and Wagner).

*Phalium* (*Semicassis*) *saburon* and its fossil forms have been reported throughout Europe from the Miocene, Pliocene and Pleistocene. Its range in the Miocene extended from Belgium and the Netherlands to Poland and Austria. It is known from the Pliocene of England, France

and Italy, but evidently its range has somewhat shrunk in the Recent. There is a natural difficulty in distinguishing fossil *saburon* specimens from those of *laevigatum* Defrance, since the latter doubtlessly gave rise to the Recent *saburon*.

**Synonymy—**

1792 *Cassidea saburon* Bruguère, Encyclopédie Méthodique (Vers), vol. 1, pt. 2, p. 420, no. 4 (l'isle de Gorée; Méditerranée; Lisbonne). Refers to several figures; Adanson, pl. 7, fig. 8; Gualtieri, pl. 39, fig. G, and others.

1793 *Buccinum arcota* [sic] Linn., von Salis, Reisen . . . Neapel, Zurich, vol. 1, p. 367, no. 37 (Naples); 1795, *ibid.*, London edition, p. 458, no. 37.

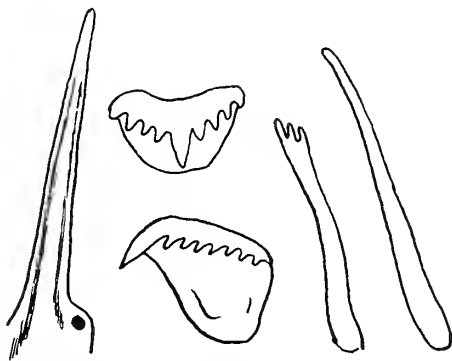


Plate 136. *Phalium* (*Semicassis*) *saburon* (Bruguère). Right tentacle and radula of a female from St. Jean de Luz, Biarritz, France.



Plate 137. *Phalium* (*Semicassis*) *saburon* (Bruguère, 1792). Figs. 1, 2, heavy form from St. Jean de Luz, Biarritz, France, 67.4 mm. Figs. 3, 4, elongate and light-weight form from Pointe-Noire, Republic of Congo, 51.9 mm. Figs. 5, 6, ovate and light-weight form, Caparica Beach, near Lisbon, Portugal, 55.5 mm.

- 1822 *Cassis saburon* Brug., Lamarck, Anim. sans Vert., Paris, vol. 7, no. 227; 1882, Bucquoy, Dautzenberg and Dollfus, Moll. Roussillon, vol. 1, p. 64, pl. 7, figs. 1, 2; 1868, Weinkauff, Conchylien de Mittelmeeres, Cassel, vol. 2, p. 39.
- 1829 *Cassis pomum* Schubert and Wagner, Conchyl.-Cabinet, Nürnberg, vol. 12, p. 71, figs. 3084, 3085 (no locality).
- 1857 *Cassis nucleus* Kiister, Martini-Chemnitz, Syst. Conch. Cab., vol. 3, pt. 1, pl. 52, fig. 3, 4.
- 1870 *Cassis (Cassidea) saburon* Bruguière, Hidalgo, Moluscos Marinos Espana. . . , vol. 2, Cassis, p. 6, pl. 3, figs. 2, 3.
- 1878 *Cassis saburon* var. *abbreviata* Monterosato, 1878, Enum. e Sinon. Conch. Medit., p. 42.
- 1882 *Cassis saburon* var. *varicosa* "Philippi", Bucquoy, Dautzenberg, and Dollfus, Moll. Marins Roussillon, vol. 1, p. 65 (refers to Kiener, 1835, pl. 14, fig. 27).
- 1886 *Cassis saburoni* Locard, Prodrôme Malac. Française, Moll. Marins, p. 147 (footnote) and p. 556. Emendation of *saburon* Brug.
- 1886 *Cassis adansonii* Locard, *ibid.*, pp. 148; 556 (Cape Breton, Roussillon; Cette).
- 1913 *Cassis saburon* var. *platystoma* "Brignone" Gignoux, Annales de L'Université de Lyon, new ser., fasc. 36, pt. 5, p. 529, pl. 15, fig. 1, 1 a (Quart.; Sicily).
- 1900 *Cassis (Semicassis) saburon* Brug., var. *minor*, *crassa* and *ex-colore* Pallary, Jour. de Conchyl., vol. 48, p. 298 (Oran).
- 1909 *Cassis saburon* Brug., var. *costulata* and *nigra* Argüelles, Boletín Sociedad Aragonesa Ciencias Naturales, Zaragoza, vol. 8, no. 2, pp. 43, 44.
- 1935 *Phalium (Semicassis) saburon* (Bruguière), Bayer, Zoolog. Mededeel., Leiden, vol. 18, p. 105.
- 1935 *Phalium saburon* var. *monterosatoi* Bayer, *ibid.*, p. 105. New name for *abbreviata* Monterosato, 1878, non Lamarck, 1822.
- 1962 *Cassis saburoni* Bruguière, Pasteur-Humbert, Travaux L'Inst. Sci. Chérifien, ser. Zool. no. 23, p. 68, fig. 99 (Moroc).

**Types**—The type locality is Sénégal, West Africa. According to E. Fischer-Piette the type, once belonging to Adanson, is now safely housed in the Muséum d'Histoire Naturelle in Paris. It is well-illustrated in the Journal de Conchyliologie, vol. 85, pl. 5, figs. 6a, 6b. Its length is 37.5 mm.; width; 27.5 mm. Our specimen on plate 6, fig. 18, closely resembles the type. The type of *pomum* Schubert and Wagner is in the Zoological Museum in Copenhagen.

**Records**—(Mediterranean). SYRIA: (Weinkauff, 1868, p. 40). TURKEY: Izmir (Smyrna) (Weinkauff, 1868, p. 40). GREECE: (Conemenos, ANSP). ITALY: Tarento; Sicily; Sardinia (Weinkauff, 1868, p. 40); Naples (USNM). SPAIN: Valencia (MCZ); PORTUGAL: common offshore along the west and south coasts (A. Nobre, 1932, p. 125, pl. 20); Caparica Beach, 5 miles south of Lisbon (P. Delpont, ANSP). ALGERIA: Algiers (USNM); Cape Falcon, near Oran (MCZ). MOROCCO: Méhilla (Cayetano, ANSP); Agadir (Franz Steiner, ANSP). FRANCE: Bay of Biscaye; mouth of the Gironde River (MCZ); d'Arcachon, 40-70 fms. (Mus. Roy. Hist. Nat. Belg.; MCZ). AZORES: Pico; San Miguel (both Mus. Roy. Hist. Nat. Belg.). SENEGAL: (Adanson, 1757). GHANA: Accra (Buchanan, 1954, Jour. West African Sci. Assoc., vol. 1, no. 1, p. 36).



Plate 138. Operculum of *Phalium (Semicassis) saburon* (Bruguière). Biarritz, France. Shell, 67.5 mm.; operculum, 24 mm.

### European Tertiary *Phalium*

A host of forms belonging to this genus occurs in the Tertiary of Europe. There appear to be four general types, one leading to the Recent *saburon*, another to the *Phalium (Tylocassis) granulatum* complex, and a third which may be associated with the South African-Australian *pyrum* group. The fourth fossil, *striatellum* Grateloup from the Oligocene, may have given rise to the present-day *Semicassis* of the Indo-Pacific. No attempt is made to review these forms, but we are listing them below. I place all of them in the genus *Phalium*.

*Cassis laevigata* Defrance, 1817, Dictionnaires Sci. Nat., vol. 7, p. 210; Sacco, 1890, I Moll. Terr. Terz. Piemonte, pt. 7, pl. 1, figs. 30-35 (with new form names; *pliosulcatissima*, *pliodentata*, *plioasulcata*, *pliomalleata*, *plioinflata*, *pliogigantea*, *depressa*, *pliogloboides*, *pliodepressa*, *magnodentata*, *malleata*, *plio-crassa*, *pliolonga*, *additamentata*, *pluriplacata*, all Sacco); 1907, Sacco, Palaeontologia Universalis, p. 137, cotypes fig'd. *Cassis striata* Defrance, 1817, is a synonym (non J. Sowerby, 1812). Pliocene of Italy. Ruggier (1965, p. 150, Geol. Soc. Amer. special paper 84) believes *platystoma* "Bruguière" Gignoux, 1913, to be a synonym.

*Semicassis miolaevigata* Sacco, 1890, I Molluschi dei Terreni Terziarii Piemonte, pt. 7, p. 26, pl. 1, figs. 23-29 (with new form names: *miostrata*, *binisulcata*, *granulosa*, *rotunda*, *ovata*, *raristriata*, *miogloboides*, *tuberculata*, *depressa*, *laticauda*, *bidepressa*, *crassa*, *alata*, *limneoides*, *buccinoides*, *canaliculata*, *edentata*, *rotundo-varicosa*, *mioblonga*, *transiens*, *ornata*, *taurinensis*, all Sacco, 1890); 1924,





Plate 139. *Phalium* (*Semicassis*) *laevigatum* (Defrance, 1817). Tertiary of Italy. Holotype in Caen Museum. 54 mm.

Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 76, pl. 12, figs. 14-15. Miocene of Italy. See also Glibert, 1952, Inst. Royal Sci. Nat. Belgique, Mém. 121, p. 83, pl. 6, fig. 12.

*Cassis dewalquei* von Koenen, 1872, Schriften Gesell. Beförd. gesamt. Nat. Marburg, vol. 10, abh. 3, pt. 1, p. 206, pl. 1, fig. 7. A synonym of *bicoronatum* Beyrich, 1854, fide Glibert, 1952, p. 86, pl. 7, fig. 2 b, c.

*Cassis liennei* "Nyst" Dewalque, 1868, Prodrôme d'une descript. géolog. Belgique, Bruxelles, p. 421, Nude name, fide Glibert, 1952, p. 85.

*Cassis subsulcosa* Hoernes and Auinger, 1884, Die Gastropoden der Meeres-Ablagerungen der ersten und zweiten Miocänen Mediterran-Stufe, Vienna, p. 156; 1890, Sacco, var. *pedemontana* and subvar. *glabra* Sacco, I Moll. Terr. Terz. Piemonte, pt. 7, p. 38, pl. 1, fig. 38; 1952, Glibert, Inst. Royal Sci. Nat. Belgique, Mémoire no. 121, p. 85, pl. 6, fig. 13. Miocene. Anversien. Close to *Tylocassis*.

*Cassis reticulata* "Bonelli", Bellardi and Michellotti, 1841, Memorie della Accademia di Torino, ser. 2, vol. 3, p. 145 (Colledi Torino, Italian Miocene). Bonelli's name is manuscript. A finely reticulate species; 1890, Sacco, I. Moll. Terr. Terz. Piemonte, pt. 7, p. 37, pl. 1, fig. 36 (with subvars. *rugulosa* and *globosa* Sacco).

*Cassis neumayri* R. Hoernes, 1875, Die Fauna des Schliers von Ottnang, p. 18, pl. 11, figs. 11, 12 (Miocene of Ottnang); 1884, R. Hoernes

in length. (from Palaeontologia Universalis, Centuria 2, sp. 137).

and Auinger, Abhandlungen K. K. Geol. Reichsanstalt, vol. 12, pt. 4, p. 156, pl. 17, figs. 11, 12. Close to *reticulata* Bellardi and Michellotti, 1841.

*Cassis hoernesii* Sacco, 1890, I Molluschi dei Terreni Terziarii Piemonte, pt. 7, p. 50, pl. 1, fig. 51 (with subvar. *tuberculosa* Sacco, 1890). Miocene of Italy. An *Echinophoria*, fide Sacco.

*Cassis striatella* Grateloup, 1827, Bull. d'Hist. Nat. Soc. Linnéenne de Bordeaux, vol. 2, pt. 7, p. 20, no. 22 (St. Hean de Marsac. Dax, France); 1840, Atlas, pl. 34, fig. 15; 1924, Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 82, pl. 11, fig. 24-25.

*Cassis grateloupi* Deshayes, 1850, Traité élémentaire Conch., Paris, explanation to Atlas, p. 69, pl. 116, fig. 2 (no locality); 1924, Cossmann and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 78, pl. 11, figs. 34-35 (with new forms: *varicigera*, *sacyi*, *cestasensis*, all Coss. and Peyr., 1924). Lower Miocene, France. Rather close to *miolaevigata* Sacco, 1890.

*Cassis texta* Bronn, 1827, Zeitschrift für mineralogie [= Taschenbuch für die gesammte mineralogie], vol. 2, p. 532. Not seen. Synonym of *laevigata* Defrance, 1817, fide Sacco, 1890, pt. 7, p. 32. Close to the *saburon* group.

*Cassis subgranulosa* Orbigny, 1852, Prodrôme de Paleontologie Strat. Universelle, Paris, vol. 3, p. 90, no. 1675. Synonym of *grateloupi* Deshayes, 1850, fide Cossmann and Peyrot, 1924, p. 78.

*Cassis incrassata* Grateloup, 1834, Actes Soc. Linn. Bordeaux, vol. 6, pt. 35, p. 202; 1840, Atlas, pl. 34, fig. 14 (1). Close to *laevigata* Defrance and *texta* Bronn; 1924, Cossmann

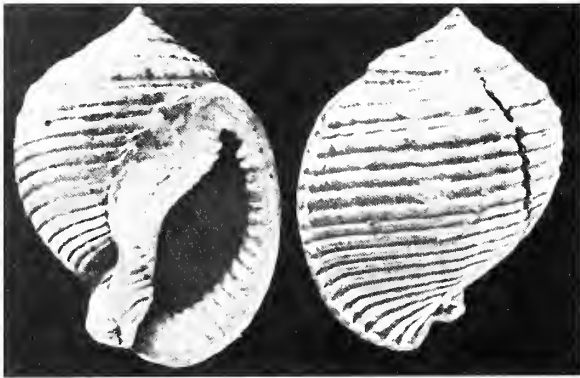


Plate 140. *Phalium* (*Semicassis*) *bicoronatum* (Beyrich, 1854). Miocene of Belgium. 39 mm. (from Glibert, 1952, pl. 7, fig. 2).

and Peyrot, Actes Soc. Linn. Bordeaux, vol. 75, p. 72, pl. 12, figs. 2-3. Miocene.

*Semicassis dumasi* Cossmann and Peyrot, 1924, Actes Soc. Linn. Bordeaux, vol. 75, p. 74, pl. 11, figs. 42, 43 (Saint-Jean-de-Marsac; Tortonien. Miocene). Close to, if not, *grateloupi* Deshayes, 1850.

*Buccinum diadema* Brocchi, 1814, Conchiologia fossile subapennina, vol. 2, p. 326, pl. 4, fig. 13 a, b (Piacentino). Undetermined; an immature form with a squarish, coronate, beaded shoulder.

*Cassis bicoronatum* Beyrich, 1854, Die Conchylien norddeutschen Tertiärgebirges, Berlin, vol. 1, p. 156, no. 6, pl. 9, fig. 4; 1952, Glibert, Institut Royal Sci. Nat. Belgique, Mémoires no. 121, p. 86, pl. 7, fig. 2. Approaching *Tylocassis*. [see pl. 138].

*Cassis adami* Eichwald, 1830, Naturhistorische

Skizze von Lithauen, Vollhynien und Podolien, Wilna, p. 222 (Shukowze and Salisze); 1853, Lethaea Rossica, Stuttgart, vol. 3, p. 173, pl. 7, figs. 24, 25. A fossil form of *saburon*.

*Cassis deucalionis* Eichwald, 1830, Naturhistorische Skizze von Lithauen, Vollhynien und Podolien, Wilna, p. 222 (Shukowze und Salisze); 1853, Eichwald, Lethaea Rossica, Stuttgart, vol. 3, p. 173, pl. 7, fig. 24 a, b. A fossil form of *saburon*.

*Cassis diluvii* de Serres, 1829. Geogn. Terr. Tert., p. 120. Probably a form of *laevigata* Defrance, 1817.

*Cassis affinis* Philippi, 1847, Palaontographica, Cassel, vol. 1, pt. 2, p. 76, no. 159, pl. 10, fig. 11 (Osterweddingen); A fossil form of *saburon*. *Philippi 1845, p. 450*, is a nude name.

*Cassis inflata* de Serres, 1829, Geogn. Terr. Tert., p. 120. Probably *Phalium laevigatum* Defrance, 1817, or *saburon* Bruguière.

*Cassis striata* Defrance, 1817, Dictionnaire Sciences Natur., vol. 7, p. 209 (Plaisantin, Italy). A form of *laevigata* Defrance, fide Sacco, 1890, pt. 7, p. 33. Non *striata* Hutton, 1873, which is now *multisecta* Finlay, 1924. Non *striata* Grateloup, 1838, which is *Sconsia striata* Lamarek.

*Cassis subareola* Orbigny, 1852, Prodrome de Paléontologie Stratigraph. Universelle. . . . . Moll., Paris, vol. 3, p. 89, no. 1664. Refers to Grateloup, 1847, Conchyl. Fossile. . . . l'Adour, suppl. pl. 1, fig. 9, which resembles a *Xenophalium*.

**Phalium craticulatum (Euthyme, 1885)**

(Pl. 141)

*Range*—Off Cape and Natal Provinces, South Africa, to southern Mozambique.

*Remarks*—This uncommon mollusk was originally described by Euthyme in 1885 and later, in 1930, by H. C. Fulton as *africana*. It is closely related to *saburon* (Bruguère) of the Mediterranean and northwest Africa, but differs in being peculiarly pinched or narrowed toward the anterior end of the shell, and in having a strong, raised, toothed, axial ridge on the inner columella. The shell is very variable. Some are small (31 mm.), very thick-shelled and with strong, crowded, irregular, spiral threads, while others are large (80 mm.), light in weight, and smooth on the middle of the body whorl. Intergrades exist. The species has been trawled in several to 180 fathoms.

*Phalium (Semicassis) microstoma* (von Martens, 1901) from deep water off Somalia is closely related, but in the absence of more material, we have kept it as a separate species. *S. microstoma* is more evenly ovate in shape, with evenly-sized spiral cords, and with a considerably rugose columellar shield. It may subsequently prove to be a subspecies of *craticulatum*.

*Description*—Adult shell 31 to 80 mm. (about 1-1/4 to 3-1/4 inches) in length, solid or somewhat fragile, ovate in shape, but narrowing anteriorly; usually spirally threaded; whitish to gray in color, with or without subdued, irregular brown-

ish red spots; and with a coarsely-toothed ridge on the inner part of the columella. Nuclear whorls 3-1/2, bulimoid, white, and smooth. Post-nuclear whorls with numerous, crowded, irregularly-sized, spiral threads which may be crossed by weak growth lines. Body whorl with 40 to 50 spiral threads which are crossed by numerous microscopic scratches giving the surface a silky sheen under high magnification. True umbilicus very small or sometimes closed. False umbilicus usually only an indentation. Parietal shield slightly glazed. Columellar shield usually smooth, except for 1 to 5 small knobs at the base. Inner columellar edge with a strong whitish ridge bearing 8 to 11 coarse teeth, the lowest often separated by a gap from the series above. Inner edge of the reflected, thickened, glossy outer lip bears about a dozen irregularly-sized teeth which are strongest below. Inside of aperture white to light-brown. Color of shell whitish to cream (sometimes artificially stained with dark red-brown) and sometimes with 5 spiral rows of weak, small red-brown blotches. Operculum horny, smoothish and very thin.

*Measurements (mm.)—*

length	width	no. whorls	
80.5	51.4	7+	large; St. Francis Bay
64.2	43.0	9	large; St. Francis Bay
53.0	35.2	8	Durban, Natal
45.7	31.5	6+	Durban, Natal
42.1	28.1	8	holotype of <i>africana</i> Fulton
30.6	20.8	7	small; Durban

*Synonymy—*

1885 *Cassis craticulatus* Euthyme, Bull. Soc. Malacologique de France, Paris, vol. 2, no. 2, pp. 250-252 (St. Elizabeth, Cape Town).



Plate 141. *Phalium (Semicassis) craticulatum* (Euthyme, 1885). Figs. 1, 2, holotype of *Cassis africana* Fulton, 1930, off Natal, South Africa, in British Museum (Natural History)

no. 19317241. 42.1 mm. Figs. 3, 4, St. Francis Bay, South Africa. 80.5 mm. Figs. 5, 6, St. Francis Bay, South Africa. 64.1 mm. (courtesy of D. H. Kennelly).



- 1930 *Cassis africana* Fulton, Annals and Mag. Nat. Hist., series 10, vol. 6, p. 686, pl. 18, fig. 3 (off Natal, South Africa).  
1935 *Phalium pila* var. *craticulata* (Euthyme), Bayer, Zoolog. Mededeel., vol. 18, p. 105.  
1935 *Phalium* (*Semicassis*) *africanum* Fulton, Bayer, *ibid.*, p. 101.

*Types*—I was unable to locate Euthyme's type of *craticulatum*. It is not in the Musée d'Histoire Naturelle or the collections of the Ecole Nationale Supérieure des Mines in Paris. The type locality is Port Elizabeth, Cape Prov-

ince, South Africa. Fulton's holotype of *Cassis africana* is in the British Museum (Natural History) in London (Reg. no. 1931.7.24.1).

*Records*—SOUTH AFRICA: Port Elizabeth (Euthyme, 1885, p. 252); trawled in 60 fathoms, St. Francis Bay, off Elands River, Cape Province; trawled in shallow water, Durban, Natal (Helen Boswell, 1962, ANSP); 30 mi. east of Durban, Natal, 450 meters, sandy mud with stones; Galathea Station 196, Feb. 13, 1951 (Zool. Mus. Copenhagen). MOZAMBIQUE: 175 mi. ENE of Lourenço Marques, 525 meters; Galathea Station 202, Feb. 21, 1951 (Zool. Mus. Copenhagen).

### Subgenus *Tylocassis* Woodring, 1928

Type: *Phalium granulatum* (Born, 1778)

This subgenus differs from *Semicassis* solely in having small, round, raised pustules, rather than spiral wrinkles, on the columellar shield. This difference is probably not very significant. Members of this group are limited to the Atlantic Ocean.

#### Synonymy—

1928 *Tylocassis* Woodring, Carnegie Inst. Washington, publ. no. 385, p. 306. (type by original designation: *Buccinum inflatum* Shaw, 1811 = *Phalium granulatum* (Born, 1778).

### *Phalium granulatum* (Born, 1778)

The treatment of this species in this monograph differs from previous interpretations. Formerly, several species have been recognized from the Mediterranean, Caribbean and Pacific side of Central America. I believe this complex should be treated as a polytypic species of fairly long geologic standing and containing three geographically isolated subspecies. Although some workers have remarked upon the great similarity of these taxa, traditional literature



Plate 142. Section through the shell of *Phalium* (*Tylocassis*) *granulatum* (Born). The section shows the true and the false umbilicus at the base of the shell. (courtesy of Junius Sessoms).

and provincial faunistic studies have kept these "species" separate. Although some few specimens from these three geographical areas are morphologically very similar, the majority of colonies in each area show a common and peculiar range of variation. Below is a synopsis of the three Recent subspecies giving the characteristic features most common to each.

*P. granulatum granulatum* (Born, 1778)—Tropical Western Atlantic. Inner and center edge of columella slightly swollen; body whorl generally with 20 or 21 weak or strong spiral cords; brown spiral lines and long axial brown flames absent; pustules on columellar shield more numerous and finer than in *undulatum*; spire moderately produced. Operculum with weak radial ridges.

*P. granulatum undulatum* (Gmelin, 1791)—Mediterranean, Azores to Canary Islands. Inner and center edge of columella straight or slightly concave; body whorl generally with 17 or 18 strong spiral cords, between which are fine, brown lines; axial flames usually present; pustules on columellar shield proportionately larger and fewer than those in other subspecies; spire usually well produced. Operculum with strong radial ridges.

*P. granulatum centiquadratum* (Valenciennes, 1832)—Tropical Eastern Pacific from Mexico to Peru. Inner and center edge of columella slightly swollen; body whorl with about 20 to 22 low, flattish spiral cords with one or two at the shoulder being more prominent and generally bearing small knobs; brown spiral lines and axial flames absent; pustules on columellar shield about the same as those in *granulatum*; spire usually quite low. Operculum with obsolete radial ridges.

### *Phalium granulatum* subspecies *granulatum* (Born, 1778)

(Pl. 12, figs. 1-7; pl. 145-147)

*Range*—Caribbean province from North Carolina, and Bermuda, to Bahia, Brazil.

*Remarks*—I am combining what has been heretofore considered two species by synonymizing *cicatricosum* (Gmelin, 1791) with the earlier *granulatum* (Born, 1778). These forms have been separated on sculptural differences. The very well corded and sometimes beaded form, *granulatum*, is dominant from North Carolina to Mexico and Costa Rica, although unmistakable examples occur sporadically in the Ba-

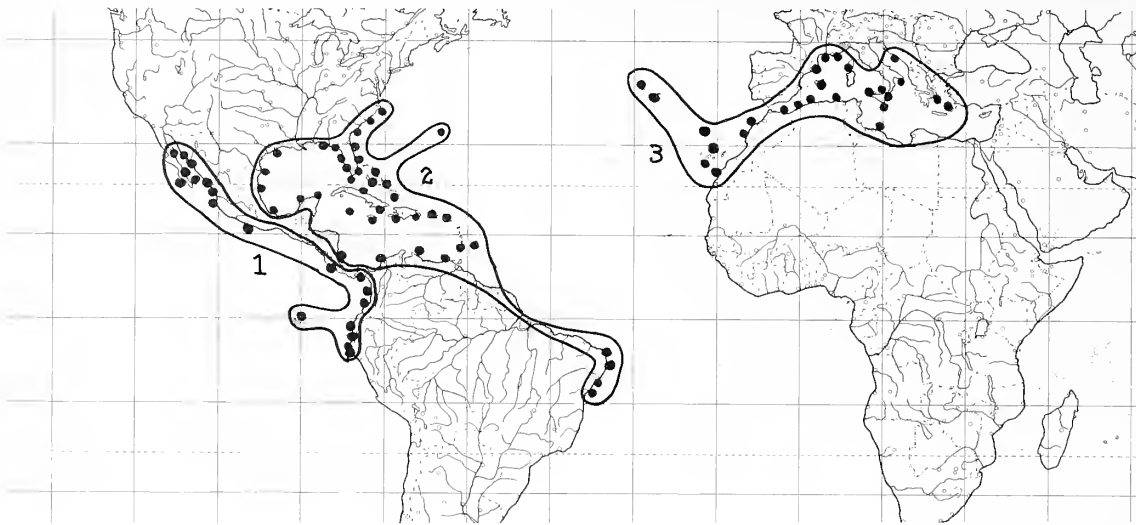


Plate 143. Geographical distribution of the subspecies of *Phalium* (*Tylocassis*) *granulatum* (Born). 1, *centiquadratum* (Valenciennes); 2, *granulatum* (Born); 3, *undulatum* (Gmelin).

hamas, Santo Domingo, Puerto Rico, Venezuela and Colombia. The smooth form, *cicatricosum*, is dominant in the West Indies and south to Brazil, although intergrades exist with the granulate form. Brazilian specimens are commonly over 90 mm. (3-1/2 inches) in length. In Florida, the smoother phase is expressed as an intergrade with a knobbed shoulder, a form named *peristephes* Pilsbry and McGinty, 1939. This variability within the species is also typical of the closely related *undulatum* (Gmelin, 1791) of the Mediterranean and *centiquadratum* (Valenciennes, 1832) of the Panamic Province. Colonies of extreme forms, having within themselves a great degree of uniformity, are responsible for the naming of these forms and their acceptance as different species. If it were not for the fact that *granulatum* forms and their intermediates existed throughout the entire range of the species, I would accept *cicatricosum* as a subspecies.

Clench (1944, *Johnsonia*, vol. 1, no. 16, pp. 6-10) deals with this complex and gives the full bibliographic listings of the synonyms which are: *Buccinum granulatum* Born, 1780; *Buccinum gibbum* Gmelin, 1791; *Cassidea granulosa* Bruguière, 1792; *Cassis malum* Röding, 1798; *Cassis cepa* Röding, 1798 (*Cassis sepa* Röding, Clench, 1944); *Cassis globulus* Röding, 1798; *Cassis minuta* Menke, 1829; *Buccinum inflatum* Shaw, 1811; *Cassis abbreviata* Lamarck, 1822; *Cassis laevigata* Menke, 1828 and 1830; *Cassis tessellata* Pfeiffer, 1840; *Cassis cicatri-*

*cosa* "Meuschen" Clench, 1944 (*Cassides cicatricosa* Meuschen, 1787 is non-binomial); *Buccinum recurvirostrum* Gmelin, 1791; *Buccinum recurvirostrum* Wood, 1818; *Xenogalea lucrativa* Iredale, 1927; *Semicassis cicatricosa peristephes* Pilsbry and McGinty, 1939. *Cassis plicata* Scopoli, 1786 (*Deliciae Florae et Faunae Insubricae*, pt. 2, p. 76, pl. 24, fig. 1) is a synonym.

*Buccinum abbreviatum* Gmelin, 1791, does not belong in this synonymy. It is a *Demoulia* in the family Nassariidae. The type of *Cassis lactea* Kiener, 1835, is a *centiquadratum* Valenciennes. Iredale's *lucrativa* is evidently based upon West Indian specimens distributed by Reeve under an incorrect label attributing the shells to "Raine's Island, Torres Strait, Australia." I examined Lamarck's type of *abbreviatum* (44.5 x 30.1 mm.; 6 whorls) and Bruguière's type of *granulosum* (74.4 x 48.9 mm.; 8 whorls) in Geneva, and they are typical West Indian specimens of *granulatum* (Born).

Heretofore, this species has not been recorded from Bermuda, but the late Mr. Ted Nielsen sent us a Pleistocene specimen found at Devon-

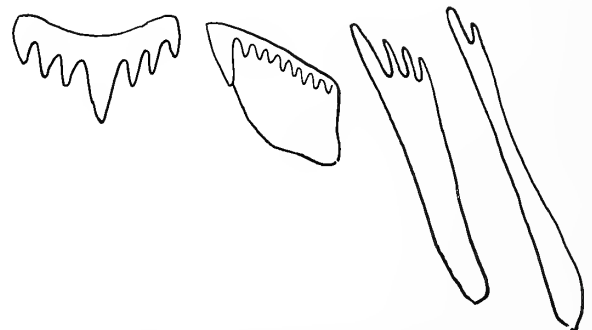


Plate 144. *Phalium* (*Semicassis*) *granulatum* (Born). Radula of female from the Virgin Islands, West Indies.



shire Bay on the south coast of Bermuda. Russell Jensen collected two broken specimens in Castle Harbour Sound in 1967 that were evidently recently killed by octopuses.



Plate 145. *Phalium* (*Tylocassis*) *granulatum granulatum* (Born, 1778). Top fig., holotype of *Cassis abbreviata* Lamarck, 1822, 44.5 mm. Bottom fig., holotype of *Cassis granulosa* Bruguière, 1792, 74.4 mm. Both types in Mus. d'Hist. Nat. Genève.

***Phalium granulatum subspecies undulatum* (Gmelin, 1791)**

(Pl. 12, figs. 11-15; pl. 148)

*Range*—Mediterranean; the Azores, Madeira and Canary Islands.

*Remarks*—This subspecies is characterized by its somewhat produced spire, and by fine, brown spiral lines between the 17 or 18 strong, spiral cords. Above, we have distinguished it from the subspecies *granulatum* (Born) of the Western Atlantic and the subspecies *centiquadratum* (Valenciennes) of the tropical Eastern Pacific. *S. g. undulatum* may sometimes bear small knobs on the shoulder and have a lower spire. It differs from the Eastern Atlantic *saburon* (Bruguière) which is smaller, more globular, has a sealed false umbilicus and has only 3 to 10 small pustules on the lower part of the columellar shield. *P. g. undulatum* is moderately common throughout the Mediterranean.

*Measurements (mm.)—*

length	width	no. whorls	
111.0	64.0	8	large; Mediterranean
92.0	61.0	9	average; Yugoslavia
91.0	54.5	8	type of <i>sulcosa</i> Bruguière
53.8	34.1	8	small; Spanish Morocco

*Synonymy—*

- 1791 *Buccinum undulatum* Gmelin, *Systema naturae*, ed. 13, p. 3475, no. 18 (locality not stated); refers to Lister, pl. 996, fig. 61.
- 1791 *Buccinum trifasciatum* Gmelin, *ibid.*, p. 3477, no. 30; refers to Bonanni, fig. 158.
- 1791 *Buccinum bilineatum* Gmelin, *ibid.*, p. 3476, no. 23 (locality unknown). Refers to Lister, pl. 998, fig. 63.
- 1792 *Cassidea sulcosa* Bruguière, *supra cit.*, p. 422 (Jamaica [error]); refers to Bonanni, fig. 159; Petiver, pl. 152, fig. 8; and others. [Non *Buccinum sulcosum* Born, 1778, which is a *Tonna*, and does not preoccupy this name.]
- 1817 *Buccinum horcatum* "Solander" Dillwyn, *Desc. Cat.* vol. 2, p. 595 (nude name).
- 1822 *Cassis sulcosa* Brug., Lamarck, *Anim. sans Vert.*, vol. 7, p. 226.
- 1852 *Semicassis variatum* "Martyn" Mörch, *Catalog Conchyl.* Yoldi, p. 112.
- 1857 *Cassis sulcosa* var. *minor* Küster, Martini and Chemnitz, *Syst. Conchyl.-Cab.*, series 2, vol. 3, pt. 1b, p. 44, pl. 53, figs. 3, 4. (not *minor* Küster, *ibid.*, p. 43.).
- 1868 *Cassis sulcosa* Brug., var. *tuberculata* and var. *globosa* Weinkauff, *Die Conchylien des Mittelmeers*, Cassel, vol. 2, p. 43 (Mediterranean). [form names].
- 1870 *Cassis* (*Cassidea*) *undulata* Gmelin, Hidalgo, *Moluscos Marinos Espana*. . . , vol. 2, *Cassis*, p. 2, pl. 3, fig. 1.
- 1878 *Cassis undulata* var. *ampullacea*, var. *crassa*, var. *elongata*, var. *varicosa*, var. *granulata* [all] Monterosato, *Enum. e Sinon. Conch. Mediterr.*, p. 42 [all form names].
- 1882 *Cassis undulata* Gmelin, Bucquoy, Dautzenberg and Dollfus, *Les Moll. Marins du Roussillon*, Paris, vol. 1, p. 66; 1962, Paster-Humbert, *Travaux L'Inst. Sci. Chérifien*, ser. Zool. no. 23, p. 68 (Maroc).

- 1884 *Cassis undata* var. *levilabiata* de Gregorio, Bull. Soc. Mal. Italiana, Pisa, vol. 10, p. 113 (no locality).  
 1885 *Cassis ventricosa* Mart., Tryon, Manual of Conchology, vol. 7, p. 274, 299.  
 1886 *Cassis gmelini* Locard, Prodrome de Malacologie Française, p. 148 and 556.  
 1886 *Cassis decussata* Locard, Prodrome de Malacologie Française, p. 149.  
 1892 *Cassis calamistrata* Locard, Les Coquilles Marines de Côtes de France, Paris, p. 89 (Mediterranean). [new name for *Cassis decussata* Locard, 1886, non Linné, 1758].  
 1900 *Cassis* (*Semicassis*) *undulata* Linné [sic], var. *minor*, *ex-colore* and *minima* Pallary, Jour. de Conchyl., vol. 48, p. 297, text fig. 7. (Oran).  
 1935 *Phalium* (*Semicassis*) *undulatum* var. *marchesei* Bayer, Zoolog. Mededeel. vol. 18, p. 107. New name for *granulata* Monterosato, 1878, non Born, 1778.  
 1935 *Phalium* (*Semicassis*) *undulatum* var. *pusio* Bayer, *ibid.*, p. 107. New name for *minor* Küster, 1857, p. 44, non Küster, 1857, p. 43.

**Types**—The type locality of “Barbados” given by Gmelin is evidently erroneous. Gmelin may not have had a specimen. Bruguière’s type is in the Museum de Genève.

**Nomenclature**—Bucquoy, Dautzenberg and Dollfus (1882, p. 66) aptly stated that the synonymy of this shell was very complicated. The

argument has hinged on the recognition of Gmelin’s *Buccinum undulatum* which was poorly described and referred primarily to Lister’s pl. 999, fig. 61. Lister’s figure looks very much like the Mediterranean form (in possessing long wavy, axial color flames and possibly spiral color lines), despite the locality of “Barbados”. I am following the decision of these three authors rather than that of Weinkauff (1878, p. 42) who suggested that Gmelin’s name be rejected. Gmelin evidently had no specimen.

**Records**—YUGOSLAVIA: Makarska, Adriatic Sea (Jure Radic, ANSP). GREECE: Mikonos Id. (Katherine Anderson, ANSP); Delos Id. (MCZ). ITALY: Taranto; Naples; Ustica Id., n. of Sicily (all Weinkauff, 1867, p. 42); Syracuse, Sicily (M. Smith, 1909, Nautilus, vol. 22, p. 132); Palermo, Sicily (Zool. Mus., East Berlin); Gallipoli (USNM); Aci Trezza, Sicily (ANSP). FRANCE: Marseilles; Toulon (both Mus., Roy. Hist. Nat. Belg.); St. Tropez (R. Robertson, ANSP); Corsica Id. (USNM; MCZ). SPAIN: Barcelona (Mus. Roy. Hist. Nat. Belg.); Mallorca Id., Balearic Ids. (ANSP). LIBYA: Tripoli (Weinkauff, 1867, p. 42); ALGERIA: Port Gueydon (Ancey, 1898, Nautilus, vol. 12, p. 52); Cap Falan, near Oran; Bone (Mus. Roy. Hist. Nat. Belg.); Algiers (MCZ). SPANISH MOROCCO: Méhilla (Cayetano, ANSP). AZORES: Pico (Mus. Roy. Hist. Nat. Belg.). MADEIRA IDS: Porto Santo (MCZ). CANARY IDS.: La Luz, Grand Canary (Mus. Roy. Hist. Nat. Belg.); Tenerife Id. (MCZ).

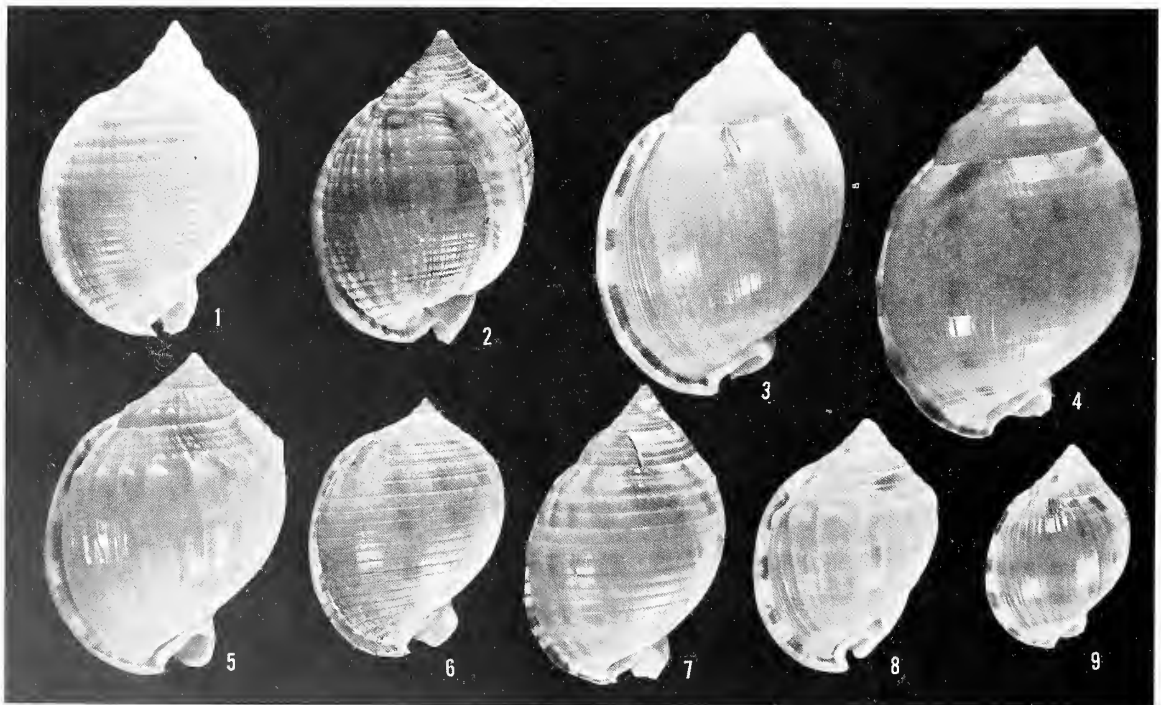


Plate 146. Sculptural variations in *Phalium* (*Tylocassis*) *granulatum* (Born, 1778). Fig. 1, off Pensacola, Florida, 42 mm. Fig. 2, Mayaguez, Puerto Rico, 44 mm. Fig. 3, smooth form *cicatricosum* (Gmelin) from St. Thomas, Virgin Islands, 50 mm. Fig. 4, 3 fms., off Key West, Florida, 75 mm. Fig. 5, holotype of *peristephes* Pilsbry and McGinty,

1939, from Boynton Inlet, Florida, 44.6 mm. Fig. 6, ovate form from Obregon, Yucatan, Mexico, 48 mm. Fig. 7, Eighth Pass, N.E. Mexico, 59 mm. Fig. 8, dwarf, nodulated form from Guantanamo Bay, Cuba, 34 mm. Fig. 9, dwarf, smoothish form from Guantanamo Bay, Cuba, 28 mm.





Plate 147. *Phalium* (*Tylocassis*) *granulatum* forma *cicatricosum* (Gmelin, 1791). Holotype of *Xenogalea lucrativa* Iredale, 1927, erroneously attributed to Torres Straits, Australia.

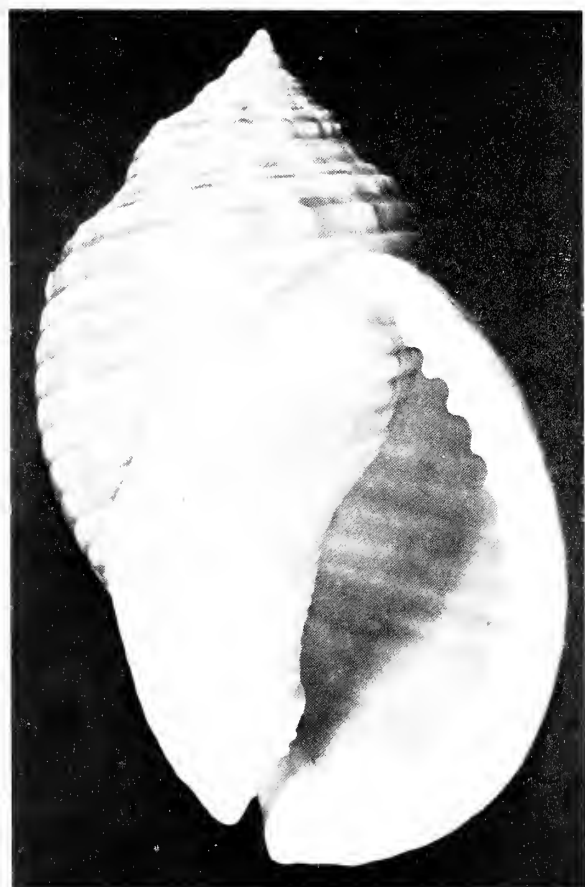


Plate 148. *Phalium* (*Tylocassis*) *granulatum undulatum* (Gmelin, 1791) from the Eastern Atlantic. Holotype of *Cassissulcosa* Bruguière, 1792, 91 mm. Mus. d'Hist. Nat. Genève.

***Phalium granulatum* subspecies  
*centriquadratum* (Valenciennes, 1832)**

(Pl. 12, figs. 8, 9; pl. 149)

**Range**—Lower California, Mexico to Northern Peru; Galapagos.

**Remarks**—The distinguishing characters of of this moderately common Eastern Pacific cassid are given above. The shell is very variable in sculpture and ranges in size from 33 to 69 mm. (1-1/3 to 2-3/4 inches). The same dwarf, thick-shelled, beaded form exists in both *centriquadratum* and the Caribbean *granulatum*. The monstrosity illustrated by Bayer (1935, p. 103, fig. 2) is merely a formerly two-variced specimen which has been broken back. Some live-collected shells have a bluish gray background. I have examined Kiener's type of *lactea* (41.1 x 29.0; 6.5 whorls) in the Museum de Genève, and believe it to be a synonym of this subspecies. Clench (1944) thought it to be the Caribbean subspecies.

Emerson and Old (1963), p. 16 report living specimens from 20 to 24 fathoms from Baja California.

**Synonymy**—

- 1832 *Cassissulcosa centriquadrata* Valenciennes in Humboldt and Bonpland, Recueile d'Observ. Zool, vol. 2, p. 310 (Acapulco).
- 1832 *Cassissulcosa dolata* Valenciennes, *ibid.*, p. 311.
- 1835 *Cassissulcosa lactea* Kiener, Coquilles Vivantes, Paris, vol. 8, p. 35, pl. 16, fig. 35 (locality unknown).
- 1935 *Phalium granulatum* subsp. *abbreviata* var. *centriquadrata* (Val.) Bayer, Zoologische Mededeelingen, vol. 18, p. 102, 103, fig. 2.
- 1958 *Cassissulcosa (Semicassissulcosa) centriquadrata* (Valenciennes, 1832), Keen, Sea Shells of Tropical West America, Stanford, p. 340, fig. 315.
- 1963 *Semicassissulcosa centriquadrata* (Val.), Emerson and Old, Amer. Mus. Novitates, no. 2153, p. 16.

**Records**—MEXICO: La Libertad, Sonoro (H. N. Lowe, ANSP; MCZ); Miramar, Guaymas (Ted Dranga, MCZ); Santa Rosalia (H. G. Richards, ANSP); San José Id. (USNM); Agua Verde Bay (USNM); Mangrove Id., Magdalena Bay, Lower Calif. (USNM); La Paz (W. M. Gabb, ANSP); Cape San Lucas (USNM; MCZ); Sta. Inez Bay; Santa Maria Bay (both USNM); Mazatlan (Ruth Ostheimer, ANSP); off Guaymas, 71 fms. (USNM); Acapulco (ANSP; USNM); Salina Cruz, Oaxaca (M. E. Bourgeois, ANSP). COSTA RICA: Puntarenas (H. N. Lowe, MCZ). COCOS ID: Wafer Bay (Paul Slud, AMNH). PANAMA: (ANSP; MCZ; USNM). COLOMBIA: Tumaco (Zool. Mus. Copenhagen); Isla de la Gallo (ANSP). ECUADOR: Cojimies (Ted Dranga, ANSP; MCZ); Manta (USNM; ANSP); Jumaco (Zool. Mus. East Berlin). PERU: Lobitos and Mancora (Olsson, 1924, Nautilus, vol. 37, p. 125). GALAPAGOS: Eden Island, off Santa Cruz Id. (Victor Zullo, 1964, ANSP).

**Fossil records**—PLIOCENE: Jama formation, Puerto Jama, Ecuador (Pilsbry and Olsson, Proc. ANSP, vol. 93, 1941, p. 40, pl. 7, figs. 3, 6).





Plate 149. *Phalium (Tylocassis) granulatum* subspecies *centiquadratum* (Valenciennes, 1832). Pliocene, Canoa formation. Punta Blanca, Ecuador. 47 mm. in length.

**Phalium granulatum**  
*subspecies aldrichi* Dall, 1890

(Pl. 150)

*Range*—Miocene of Florida (and Canal Zone?).

*Remarks*—This is one of the numerous fossil forms of *granulatum*. It is morphologically closer to the Recent Pacific subspecies, *centiquadratum*. This may be a form of *reclusum* Guppy, 1873. Woodring (1959, p. 199) says "the wart-like denticles of the type and only specimen of *aldrichi* do not extend over the parietal wall as shown in Dall's [original] illustration. . . ."

*Synonymy*—

- 1890 *Phalium aldrichi* Dall, Transactions Wagner Free Inst. Science, Philadelphia, vol. 3, pt. 1, p. 162 (Lower Miocene of the Chipola beds, N.W. Florida, at Ten-Mile Creek); 1892, pt. 2, p. 263, pl. 21, fig. 2.  
1947 *Semicassis* (*Tylocassis*) *aldrichi* (Dall), Gardner, U.S. Geol. Survey Prof. Paper 142-H, p. 536, pl. 54, fig. 6.  
1959 *Semicassis* ? (*Tylocassis* ?) cf. *S. aldrichi* (Dall), Woodring, U.S. Geol. Survey Prof. Paper 306-B, p. 199 (Culebra formation, Canal Zone, early Miocene).

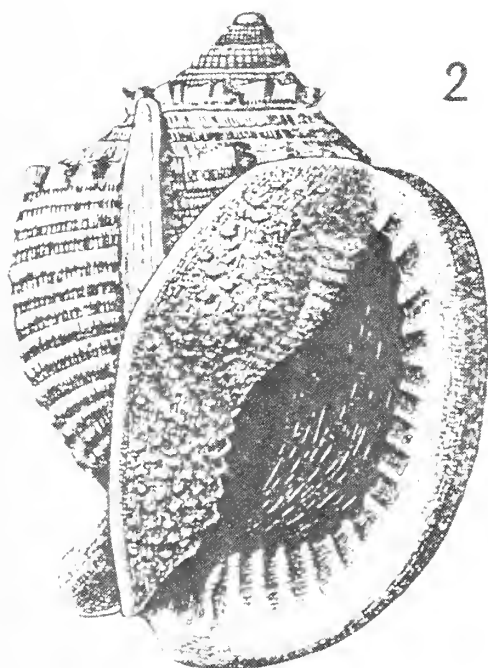


Plate 150. *Phalium* (*Tylocassis*) *granulatum* subspecies *aldrichi* Dall, 1890. Chipola River, N.W. Florida. Miocene. Length: 26 mm. Holotype from Dall, 1893 [1892 on title page], vol. 3, pt. 2, pl. 21, fig. 2.

**Phalium granulatum**  
*subspecies reclusum* (Guppy, 1873)

*Range*—Miocene of the Caribbean.

*Remarks*—This is the supposed Miocene progenitor of the Recent *granulatum* and *centiquadratum*. Numerous ecologic and genetic forms exist; most of those having been collected have had names applied to them, as can be seen in the synonymy below. The differences between these Miocene forms and the Recent colonies are probably too slight to justify anything more than form names.

*Synonymy*—

- 1866 *Cassis monilifera* Guppy, Quart. Journ. Geological Society London, vol. 22, p. 287, pl. 17, fig. 8 (Miocene, Jamaica). Non Sowerby, 1846. Type in Brit. Mus. Paleo. Dept. no. 64074, 24.0 x 17.1 mm.; 1874, Geol. Mag., decade 2, vol. 1, p. 439 (list); 1876, Quart. Journ. Geol. Soc. London, vol. 32, p. 525; 1917, Pilsbry and Brown, Proc. Acad. Nat. Sci. Philadelphia, vol. 69, p. 34 (Colombia, Miocene); 1925, Maury, Brasil Serv. Geol. Mineral. Mon., vol. 4, pl. 5, fig. 1.  
1873 *Cassis reclusa* Guppy, Proc. Sci. Assoc. Trinidad, vol. 2, no. 2, p. 84 (Miocene, Jamaica).  
1917 *Phalium moniliferum* (Guppy), Maury, Bull. Amer. Paleontology, vol. 5, p. 110, pl. 44, figs. 4-5, pl. 45, fig. 1.  
1928 *Semicassis* (*Tylocassis*) *reclusa* (Guppy), Woodring, Carnegie Institute, Wash. D.C., Publ. no. 385, p. 307, pls. 19 and 20; 1959, U.S. Geol. Survey, Prof. Paper 306-B, p. 200, pl. 34, figs. 1, 4-6.  
1925 *Phalium paraensis* Maury, Brasil Serv. Geol. Mineral. Mon., vol. 4, p. 119, pl. 5, figs. 5-7 (Rio Pirabas, Brasil, lower Miocene).  
1934 *Phalium* (*Tylocassis*) *sulcosum* var. *semiti* Rutsch. Abhandl. Schweizer. Palaeont. Gesell., vol. 54, p. 55, pl. 3, fig. 1, 2 (Miocene, Punta Gavilan formation of Venezuela). Spire higher.  
1935 *Semicassis* (*Tylocassis*) *inflata waltonensis* Mansfield, Geol. Bull. no. 12, Dept. of Conservation, Florida, p. 40, pl. 4, figs. 5, 9 (Station 12046, Vaughan Creek, Walton Co., Florida; Upper Miocene).  
1938 *Semicassis* (*Tylocassis*) *maleaformis* Vokes, American Museum Novitates, no. 988, p. 24, fig. 22 (Upper Miocene, Springfield, Trinidad). Badly crushed specimen.

**Phalium caelaturum** (Conrad, 1848)

*Range*—Oligocene of Vicksburg, Mississippi.

*Remarks*—This species bears small *Tylocassis*-like pustules on the lower part of the columellar shield. The more elongate shape of the entire shell and the rather strong, sharp beads on the body whorl distinguish this unique species from the *granulatum-reclusum* series. Types in ANSP nos. 13499 and 13500.

*Synonymy*—

- 1847 *Cassis caelatura* Conrad, Proc. Acad. Nat. Sciences Philadelphia, vol. 3, p. 288 (Vicksburg, Mississippi).  
1922 *Cassis* (*Phalium*) *caelatura* Conrad, Pilsbry, Proc. Acad. Nat. Sci. Phila., vol. 73, p. 362 (chart).

*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*



### Subgenus *Xenophalium* Iredale, 1927

Type: *Phalium pyrum royaum* (Iredale, 1914)

Members of this subgenus generally live in cold temperate waters. The shells closely resemble those of the subgenus *Semicassis*, but differ in having a much smoother columellar shield, fewer denticles or tooth-like lirae on the outer lip and in seldom having strong spiral sculpturing. There is a dark-brown color splotch on the end of the siphonal notch in most species. The tentacles of most species examined bore two long, narrow longitudinal stripes. The penis has an open seminal groove running to the distal end, and, unlike other *Phalium*, has numerous fleshy papillae on the surface of the underside. The outer marginal radular tooth usually lacks denticles. The operculum is fan-shaped and usually smoothish.

Of the six known species, five are found in the southern hemisphere and one in Japan. One species, *labiatum*, is circum-antarctic in its distribution. Shells in this subgenus are renowned for the variability in shape and sculpturing, a fact which has led to the description of the many ecologic and minor genetic forms found in South Australia and New Zealand. *Xenogalea* Iredale is a synonym based upon species which usually show some denticulation on the outer lip.

The name *Eocassmaria*, with *Cassidea gradifera* Cossmann and Pissarro, 1909, as the type, was proposed by Vredenburg in 1928 as a new section of the subgenus *Semicassis*. This Eocene shell resembles the tabulated forms of some Australian *Xenophalium*, but because the shells are not at all well-preserved, and because the thin, outer lip suggests a juvenile form, I hesitate to accept *Eocassmaria*. It certainly bears no resemblance to the Recent *Cassmaria*.

### Synonymy—

1927 *Xenophalium* Iredale, Records Australian Museum, vol. 15, p. 333. Type by original designation: *Xenophalium hedleyi*, 1927.

1927 *Xenogalea* Iredale, Records Australian Museum, vol. 15, p. 339. Type by original designation: *Cassis pyrum* Lamarck, 1822.

?1928 *Eocassmaria* Vredenburg, Memoirs Geol. Survey India, Palaeontologia Indica, new ser., vol. 10, no. 4, p. 41. Type by original designation: *Cassidea gradifera* Cossmann and Pissarro, 1909.

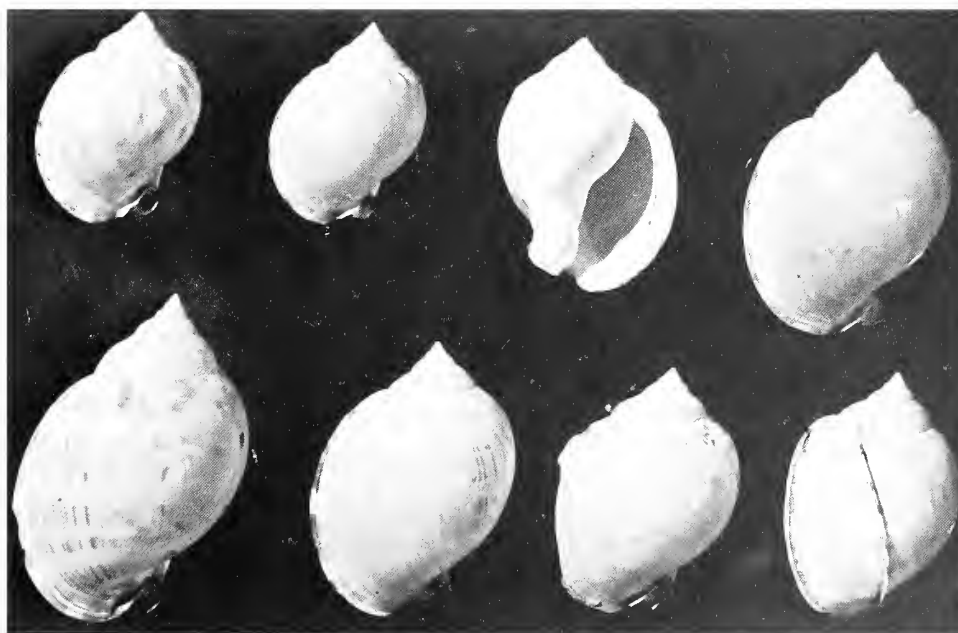


Plate 151. Variations in sculpturing and color patterns in *Phalium* (*Xenophalium*) *pyrum* (Lamarck, 1822) from off Eden, New South Wales. Collected by Neil F. Buckland,

1962. Top left shell with two rows of nodules is 55 mm. in length; others to same scale. Lower right shows extra varix.

***Phalium pyrum* (Lamarck, 1822)**

(Pls. 13, 151-157)

*Range*—Southern Australia, Tasmania, New Zealand and South Africa.

*Remarks*—I have examined many hundreds of specimens of this group from about one hundred different localities in Australia, Tasmania and New Zealand, and have come to the conclusion, not without apprehension, that the host of species described by Cotton, Iredale, Powell and others are in reality nothing but local ecologic forms or random, local, concentrations of minor genetic forms. I have before me collections of a dozen or more specimens from one locality representing several "species" but which, through a series of specimens, show gradual intergradation in shape, coloring and sculpture. Most of these so-called species were based upon one or two specimens brought into museums over the years by deep-water fishermen. The first non-typical form was described as *niveum* by Brazier in 1872. It was a small, whitish, shouldered specimen, bearing two spiral rows of small, rounded nodules, and was collected by W. F. Petterd, Jr. at Macquarie Harbour, west Tasmania. Since then, similar specimens have been found in Victoria, Western Australia, and New South Wales, together with specimens having more elevated spires and less pronounced nodules on the shoulder. Around this form, which may range in size from 45 to 90 mm., and vary from white to brownish peach, are several similar but intergrading forms which have received the species names of *spectabile* Iredale, 1929, and *mawsoni* Cotton, 1954.

In 1914 Hedley described *stadiale* which is the dominant form off southeast Australia. Other specimens collected by the F.I.S. "Endeavour" at the same time and in the same areas, and having intergrading characters, were evidently not seen by Hedley. They are now in the National Museum of Victoria and bear labels reading "*C. stadialis* var.". Had Hedley seen other specimens, he doubtlessly would have connected his *stadiale* with typical *pyrum*. Other workers, believing that size, thickness of shell, development of columellar plicae, outer lip dentition and shoulder nodulation were species criteria, gave species names to some of the forms similar to if not identical with *stadiale*, such as *denda* Cotton, 1954, *halli* Cotton, 1954 and *wilsoni* Cotton, 1954.



Plate 152. *Phalium pyrum* (Lamarck). Radula of forma *hamiltoni* from New Zealand. (After Powell, 1928, p. 632).

In New Zealand considerable attention has been given to the *pyrum* complex, both Recent and fossil. Although many areas around New Zealand, particularly on the west side, are yet to be sampled for cassids, a pattern of distribution is evident from the specimens at hand. In the relatively shallow inshore waters one finds the common, colorful, noded form which New Zealand workers refer to as typical *pyrum*. It has been more commonly collected around North Island. An ecologic shallow-water cline appears to be present towards the south in which the shells become heavier, with attending denticles on the inside of the outer lip and slightly stronger plicae on the columella. This is a common phenomenon in other cassids when the ends of the range extend into cooler waters. This heavier form reaches its maximum expression at the south end of South Island and just across Foveaux Strait around Stewart Island. It is forma *harrisonae* (Powell, 1928). This forma was also produced during the Upper Pliocene at Castlecliff, Wanganui, North Island, suggesting that ecologic conditions were similar to those of today. The persistence of minor genetic and/or ecologic forms from even as early as the Miocene is not an uncommon phenomenon in cassids and other families, and the element of what seems to be a long time to man should not influence the recognition of separate species names for the fossils.

Another major cline in the New Zealand *pyrum* complex is correlated with depth of water and, hence, probably with temperature, salinity, bottom sediments and water flow. Along the shelf off the eastern sides of South Island and the southern half of North Island a host of smooth, more or less globose and less colorful forms have been dredged in 40 to 155 fathoms. Some specimens intergrade with typical *pyrum*. Off Castlepoint, southeast North Island, and off

other areas near Wellington in 2 to 70 fathoms several of the named forms (*hamiltoni*, *powelli*, *abernethyi* and their intergrades) have been brought up, sometimes in the same trawl net. The forma *finlayi* (Iredale, 1927) is common to the south near Otago Peninsula in 45 to 80 fathoms. Doubtlessly, other deep-water forms will be found there when more samples are taken. Both Australian and New Zealand workers tend to recognize deep water, ecologic forms as species, but inevitably the intergrades are sooner or later collected in shallower water. The forma *finlayi* does not differ significantly from the Australian forma *stadialis* (Hedley, 1914), except that the former may have stronger, incised lines on the early postnuclear whorls and on the base of the body whorl. Rather significantly, Dell (1956, p. 87) points out that his *abernethyi* "combines in part the shape of *hamiltoni* Powell with the denticulate aperture of *harrisonae* Powell." Other combinations are also evident.

As in the case in the widely distributed *Phalium* (*Semicassis*) *bisulcatum* (Schubert and Wagner), the type of bottom and the depth and temperature of water seem to produce about the same kind of ecotypes. In the New Zealand deep-water *pyrum*, the shell tends to be darkly stained, eroded, lustre-less, somewhat globose and generally with more thickened shell walls. These colonies have received such names as *abernethyi* Dell, 1956, *hamiltoni* Powell, 1928, *finlayi* Iredale, 1927, and *matai* Powell, 1952.

Curiously, the rather distinct form found commonly cast up on the beaches of Mangawai, Hokeo, Muriwai and Great Barrier Island has

not received a name. It differs from Lamarck's type of *pyrum* from South Australia in being usually smaller, with more numerous nodules on the shoulder and in being very brightly colored with spiral rows of red-brown squares, arrows or zigzag blotches. Specimens intergrade with the other New Zealand forms already described, and if one were to name this colorful form, it would necessitate applying names to the other numerous variants as well. There are specimens from Ulberstone, northern Tasmania, which are almost indistinguishable from some North Island, New Zealand, specimens, suggesting not only a similar environment, but also suggesting the possible and not too geologically-distant origin of the New Zealand immigrants.

South African specimens of typical *pyrum* are evidently rare, at least in collections, and some of them show *labiatum* characters such as a thick, glossy surface and white spotting. As I mentioned under the remarks of *labiatum*, South African specimens in this complex show such an extraordinary variation that it is difficult to conclude if hybridization is occurring between *pyrum* and *labiatum* or if some South African *labiatum* are expressing ancestral *pyrum*-like features.

Reports of *pyrum* from Mauritius are based on a Liénard Collection specimen which I have seen in the Mauritius Institute collection. I suspect that the shell came from South Africa. Shell specimens have been turning up in Fiji, but they look suspiciously like specimens from New South Wales.

It is characteristic of small cassids elsewhere in the world not only to exhibit remarkable indi-



Plate 153. *Phalium* (*Xenophalium*) *pyrum* (Lamarck). Australian forms. Figs. 1 and 2, holotype of *Cassidea stadialis* Hedley in the Australian Museum no. E. 4430, between Green Cape and Gabo Island, southeast Australia. Figs. 3

and 4, holotype of *Xenogalea spectabilis* Iredale in the Australian Museum no. C. 57722, off Montague Island, New South Wales. (photos courtesy of D. F. McMichael).



vidual variation, but also to congregate some of these variations within very local and perhaps somewhat isolated colonies. These colonial concentrations may reflect local environmental conditions, but they may also represent a more or less uniform genetic similarity brought in through successful swarms of free- and long-swimming veligers.

This "lumping" view is not necessarily correct in all cases, but the present alternative would be to continue describing each colony or unusual variant as new. I have before me numerous variations which are undescribed, and a "splitting" treatment of them would doubtless result in several dozen new species. In view of the probably long-swimming larval stage in all cassids and because of the available migratory ocean currents, I believe it would be unwise to elevate forms or local variants to the rank of species or subspecies.

I have included as large a series of photographs of these forms as space and expense will allow, and have retained several well-known names as *forma*. Should subsequent experimentations and research prove these to be good species, they may be elevated once again to species or subspecies rank.

Below is an outline of the subspecies and *forma* of *pyrum* which seem worthy of recognition for possible use in ecologic and distributional surveys. The recognition of the forms is arbitrary, since so many intergrades exist.

*subspecies pyrum* (Lamarck, 1822). Tasmania; Australia; New Zealand; South Africa.

*forma stadiale* (Hedley, 1914). Southeast Australia. (syn.: *denda* Cotton, 1945; *wilsoni* Cotton, 1954; *halli* Cotton, 1954).

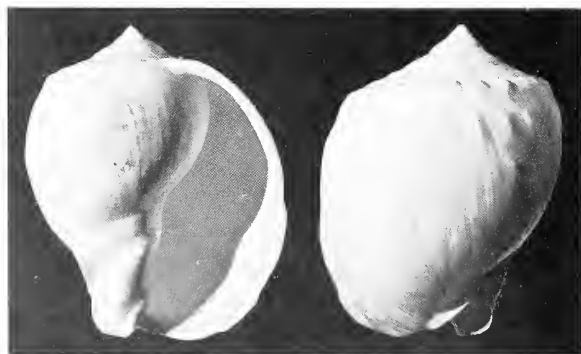


Plate 154. *Phalium* (*Xenophalium*) *pyrum* (Lamarck) *forma niveum* (Brazier, 1872). Holotype of *Cassid nivea* Brazier in the Australian Museum no. C. 11498 from Macquarie Harbour, Tasmania. 51 mm. in length. (photos courtesy of D. F. McMichael).

*forma nivenm* (Brazier, 1872). Southeast Australia. (syn.: *mawsoni* Cotton, 1945).

*forma spectabilis* (Iredale, 1929). Southeast Australia.

*forma finlayi* (Iredale, 1927). New Zealand. (syn.: *matai* Powell, 1952).

*forma hamiltoni* (Powell, 1928). New Zealand. (syn.: *abernethyi* Dell, 1956).

*forma wanganniense* (Powell, 1928). Upper Pliocene, New Zealand.

*forma powelli* (Finlay, 1928). New Zealand.

*forma harrisonae* (Powell, 1928). New Zealand.

*subspecies royanum* (Iredale, 1914). Australia-N.Z.-Kermadecs.

*forma ericanum* (Powell, 1928). New Zealand.

*forma hedleyi* (Iredale, 1927). New South Wales.

*Description (of Lamarck's type of pyrum)*—Adult shell moderately heavy, solid, ovate, and with 8 whorls. Length 63.2 mm; width 44.0 mm. Color of outer shell dirty yellow-brown with reddish brown (ecologic) staining. Nuclear whorls 3, white and smooth. Post-nuclear whorls with 8 to 10 fine spiral threads crossed by numerous axial growth lines. The most prominent thread on the shoulder of the whorl becomes stronger in the penultimate whorl and bears about 24 small, evenly-sized beads. In the last whorl the cord disappears and the beads develop into axially pinched small knobs. Below the suture is a distinct spiral incised line. At the base of the whorl there are 3 or 4 very weak spiral incised lines. Last varix moderately developed, white, with 5 weak, brown spots, and is reflected. True umbilicus small but very deep; false umbilicus chink-like. Parietal and columellar area heavily glazed with enamel-white. Columella with 4 very weak plicae in the middle and bounded below with a larger, single plica. Inside of aperture dark-brown. Siphonal canal short, its end with a dark, chocolate-brown splotch. Channel between the siphonal canal and base of body whorl is moderately wide and rounded in cross-section.

*Synonymy (see also under forma)*—

1822 *Cassid pyrum* Lamarck, Anim. sans Vert., Paris, vol. 7, p. 226, no. 16 (Nouvelle-Hollande); 1835, Kiener, Coquilles Vivante, Casque, vol. 8, p. 39, pl. 13, fig.

25 (type), pl. 15, fig. 30; 1867, Angas, Proc. Zool. Soc. London, p. 197; 1857, Küster, Martini and Chemnitz's System. Conchylien-Cab., vol. 3, pt. 1b, pl. 47, figs. 5, 6; 1859, Chenu, Manuel de Conchyl., Paris, vol. 1, p. 207, fig. 1130.

- 1840 *Cassidea pyrum* Lam., Swainson, Treatise on Malacology, London, pt. 2, p. 299.
- 1873 *Semicassis (Casmaria) paucirugis* Menke, Brazier, Proc. Zool. Soc. London, for 1872, p. 838; 1877, Angas, Proc. Zool. Soc. London, for 1877, p. 183.
- 1886 *Cassidix tumida* Petterd, Papers and Proc. Royal Soc. Tasmania, for 1885, p. 321 (near River Leven).
- 1913 *Phalium (Cassidea) labiatum* subsp. *pyrum* Lamarck, Suter, Manual New Zealand Mollusca, Wellington, p. 312, pl. 40, fig. 13.
- 1913 *Phalium labiatum striatus* Hutton, Suter, *ibid.*, p. 312. Not *striatus* Hutton, 1873.
- 1924 *Phalium pyrum* Lamarck, Iredale, Proc. Linn. Soc. New South Wales, vol. 49, p. 254 (in part); 1935, Bayer, Zoolog. Mededeel, Leiden, vol. 18, p. 110.
- 1924 *Cassidix pyra* Lam., Finlay, Trans. Proc. New Zealand Inst., vol. 55, p. 524.
- 1927 *Xenogalea pyrum* (Lamarck), Iredale, Record Australian Mus., vol. 15, p. 339, pl. 32, figs. 14, 16; 1962, Macpherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 146, fig. 175.
- 1928 *Xenophalium pyrum* (Lamarck), Powell, Trans. Proc. New Zealand Inst., vol. 59, p. 638, figs. 20-22; 1961, Powell, Shells of New Zealand, pp. 11, 38, 93, pl. 1, fig. 14.

**Types**—The type of *pyrum* Lamarck, 1822, is in the Museum de Genève. The type locality is "Nouvelle-Hollande". Iredale (1927, p. 340) suggested that the type probably was collected by Péron and Lesueur in southern Tasmania, and Cotton (1954, p. 4 of No. 4: Family Cassididae, Roy. Soc. So. Aust., Mal. Sect.) designated southern Tasmania as the type locality.

**Records**—(for specimens which closely resemble the type of *pyrum* or have a moderate degree of variation). SOUTH AFRICA: 60 fms., off Mossel Bay, Cape Province; from fish stomach, off Durban, Natal (both Helen Boswell, ANSP). AUSTRALIA: SOUTH AUSTRALIA: Middleton (MCZ); Encounter Bay (USNM). VICTORIA: Portland; San Remo; Western Port; Green Cape to Gabo Id., "Endeavour"; Lakes Entrance; Bass Straits; Port Sea (all Nat. Mus. Vict.); Richmond, near Melbourne (A. F. Kenyon, ANSP); between Flinders and Gabo Id., deep water (West. Aust. Mus.). TASMANIA: Georgetown (USNM); Port Sorell (MCZ); Clark Id.; Maria Id.; Buchmakers Beach (all Nat. Mus. Vict.); between Ulverstone and Stanley (Joy Kerslake, ANSP); Fredrick Henry Bay (G. Pridmore, 1967, ANSP); Pegg's Beach, Stanley (Joy Kerslake coll.). NEW ZEALAND: NORTH ISLAND: Ahipara, Ninety Mile Beach; Motutara, Muriwai; Hokeo Beach, near Levin (all V. Orr, ANSP); Whangarei Heads (Lorna Seager, ANSP); Mangawai (A. Jeakings, Auck. Mus., ANSP); Whangapoua Beach, Great Barrier Id., (Dom. Mus.); Tauranga; Ohope Beach; Moari Bay, Auckland (all MCZ); Cape Colville (ANSP); Mount Maunganui (ANSP); Whakatane (B. R. Bales, ANSP); Paraparauma (MCZ; ANSP); Castlepoint (Dom. Mus.); Waikanae, Wellington (Dom. Mus.; MCZ). SOUTH ISLAND: West Haven Heads, Nelson (A. W. B. Powell, Auck. Mus.; ANSP); Middle Bank, 30 fms., off Kaitiaki (F. Abernethy, Dom. Mus.). [*forma harrisonae* (Powell, 1928); Mason's Bay, Stewart Id. (Dom. Mus.; MCZ; ANSP; Auck. Mus.); Te Waewae Bay, Southland, South Id. (Dom. Mus.).]

**Fossil records**—NEW ZEALAND: UPPER PLIOCENE: Castlecliff, Wanganui, North Island (*forma* typical; *forma wanganuiense* (Powell, 1928) and *forma harrisonae* (Powell, 1928), fide Powell, 1928, p. 638.

## Australian Forms

### *forma stadiale* (Hedley, 1914)

(Pl. 13, fig. 11; pl. 153, figs. 1, 2)

**Range**—Southeastern Australia, Tasmania, 15 to 100 fathoms.

**Remarks**—This name was placed upon a specimen taken by the F.I.S. "Endeavour" in 50 to 100 fathoms between Green Cape and Gabo Island, southeast Australia. The shell is rather light in weight, smooth shouldered, with a moderately high spire, light-buff to yellowish with sparse blotches of brownish arranged in spiral rows. Below the suture there is a single weak, incised line or indentation. The lower third of the columella has 7 or 8 weak, spiral plicae. The base of the body whorl has 3 or 4 very weak, spiral lines. From the same trawl haul off Australia the "Endeavour" secured variants showing weak nodules on the shoulder. Other variants from New South Wales have a smoother columellar shield and zigzag axial flames of chestnut brown. The New Zealand analogue is *forma finlayi* (Iredale, 1927). The type of *stadiale* is in the Australian Museum, no. E 4430. Of the synonyms created by Cotton, *halli* is the only mature and well-colored specimen, which shows weak dentitions on the outer lip and weak plicae on the inner columellar region.

### Measurements (mm.)—

length	width	no. whorls	
87.1	58.0	7+	holotype of <i>wilsoni</i> Cotton
85.5	53.7	8	holotype of <i>halli</i> Cotton
84.9	60.0	8	holotype of <i>denda</i> Cotton

### Synonymy—

- 1902 *Cassidea turgida* Hedley, Mem. Australian Mus., vol. 4, p. 340, pl. 36, fig. 1.
- 1914 *Cassidea stadialis* Hedley, Biol. Results, F.I.S. "Endeavour", vol. 2, p. 72, pl. 10, fig. 4 (between Green Cape and Gabo Id.).
- 1916 *Cassidix achatina* var. *stadialis* Hedley, Gatliff and Gabriel, Proc. Roy. Soc. Vict., vol. 29, p. 108.
- 1918 *Phalium stadiale* Hedley, Hedley, Jour. Roy. Soc. New South Wales, vol. 51, p. M 67.
- 1927 *Xenogalea stadialis* (Hedley), Iredale, Record Australian Mus., vol. 15, p. 341, pl. 31, fig. 3; 1962, Macpherson and Gabriel, Marine Moll. Victoria, Melbourne, p. 151, fig. 179.
- 1945 *Xenogalea denda* Cotton, Trans. Roy. Soc. South Australia, vol. 69, no. 1, p. 169 (100 fms., west of Eucla); 1945, *ibid.*, no. 2, p. 250, fig. A. Type in the So. Aust. Mus., no. D 5332.
- 1954 *Xenogalea halli* Cotton, No. 4: Family Cassididae, Mal. Sect., Roy. Soc. South Australia, 2nd page, fig. 15 (off West Island, 15-16 fms., Victor Harbour). Type in the So. Aust. Mus., no. D 14509).
- 1954 *Xenogalea wilsoni* Cotton, above citation, fig. 16, and same type locality. Type in the So. Aust. Mus., no. 5331.

*Records*—(for specimens which closely resemble the type of *stadiale*, but which also may have weak or obsolete nodules on the shoulder). WESTERN AUSTRALIA: 100 fms., off Eucla, Great Australian Bight (Cotton's *denda*, 1945, p. 169); 15-16 fms., off West Island, Victor Harbour, near Adelaide (Cotton's *halli*, 1954, p. 2); deep water, Kingston (West. Aust. Mus.); from lobster pot, off Southend (Joy Kerslake, coll.). VICTORIA: off Portland (T. A. Garrard, coll.); off San Remo; Bass Straits; Lakes Entrance (all Nat. Mus. Vict.). TASMANIA: Buchmakers Beach; Three Hummock Id. (all Nat. Mus. Vict.). NEW SOUTH WALES: between Gabo Id. and Green Cape, 50-100 fms., F.I.S. "Endeavour" (Nat. Mus. Vict.); 25-100 fms., off Eden (Neil F. Buckland, ANSP); 60 fms., off Eden (Vernon Wells, MCZ); off Ulladulla (Joy Kerslake, coll.); off Port Stephens; off Forster (ANSP); 80 fms., off Mosman (B. Kaspiw, ANSP); dredged south of Montague Id. (R. Rixon, MCZ); off Sydney Heads (Mel Ward, MCZ).

### *forma niveum* (Brazier, 1872)

(Pl. 13, fig. 13; pl. 154)

*Range*—Southeastern Australia and Tasmania.

*Remarks*—This name was placed upon a somewhat immature specimen from Macquarie Harbour, west Tasmania. The type is 51 x 44 mm., thin-shelled, globose, with a short spire and a strongly shouldered body whorl which bears two spiral rows of small, rounded, rather evenly-sized tubercles. The color is pure-white, rather shining, and with a yellow tinge or stain on the outer lip, parietal wall and columella. True umbilicus small, round and deep; false umbilicus chink-like. I have before me a number of other specimens varying in length from 47 to 87 mm., some colored white, others flesh to peach. The shouldering and the development of the tubercles may be stronger or weaker than those in the type. The yellow tint found on the type is usually absent in other specimens. Some shells are quite heavy and may or may not have denticles on the inside of the outer lip.

This *forma* is an extreme variant of *pyrum* connected by a series of gradual intergrades to Iredale's *forma spectabile* and Cotton's *forma*

*mawsoni*. The latter is merely an immature expression of *spectabile*. It is impossible to assign names to some of the intergrades.

### *Synonymy*—

1872 *Cassis nivea* Brazier, Proc. Zool. Soc. London, for 1872, p. 616, pl. 44, fig. 1 (Macquarie Harbour, west coast of Tasmania. Type in the Aust. Mus. no. C 11498).

1927 *Xenogalea nivea* (Brazier), Iredale, Records Australian Mus., vol. 15, p. 344, pl. 32, fig. 13; 1962, Macpherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 151, fig. 180.

1935 *Phalium niveum* (Brazier), Bayer, Zoolog. Mededeel., Leiden, vol. 18, p. 110.

*Records*—WESTERN AUSTRALIA (south coast): Bremer Bay (West. Aust. Mus.). SOUTH AUSTRALIA: Encounter Bay (W. T. Bednall, 1897, ANSP); Beachport (C. F. Kurtze, ANSP). VICTORIA: Portsea; Portland (both Nat. Mus. Vict.); Richmond, near Melbourne (A. F. Kenyon, ANSP). NEW SOUTH WALES: off Eden (Joy Kerslake, coll.). TASMANIA: Macquarie Harbour (Brazier, 1872, p. 616); Kensington (ANSP); Hobart (Joy Kerslake, coll.).

### *forma spectabile* (Iredale, 1929)

(Pl. 13, fig. 12; pl. 153, figs. 3, 4)

*Range*—Southeast Australia and Tasmania; 50 to 120 fathoms.

*Remarks*—This name was placed upon a 100 mm., globose, pinkish cream, rather thin-shelled specimen having 3 spiral cords or ridges on the shoulder of the body whorl. The middle cord bears a number of closely-spaced, low, small nodules. The shell was dredged off Montague Island, New South Wales, in 50 to 60 fathoms. This is an uncommon form which connects with *niveum* and *stadiale*, all intergrades existing in specimens before me. Cotton's *mawsoni* differs only in being immature, in having a few more nodules on the main cord of the shoulder, and in having a few elongate nodules in a spiral series just below the main cord. It approaches

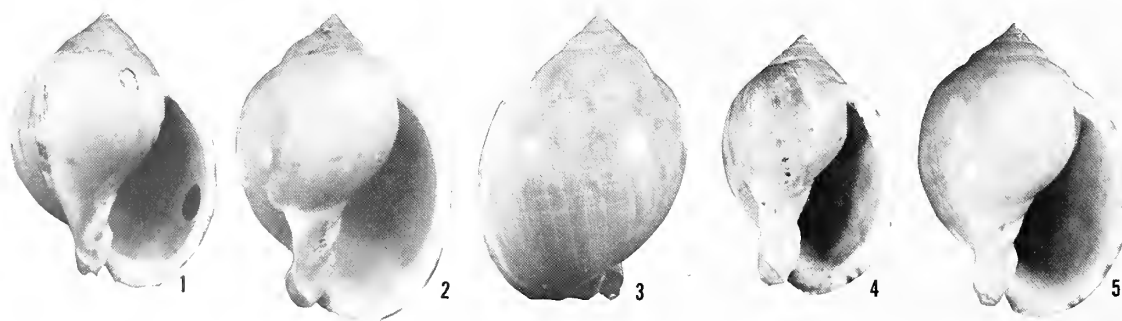


Plate 155. New Zealand forms of *Phalium* (*Xenophalium*) *pyrum* (Lamarck). Figs. 1-4, *forma finlayi* (Iredale). Fig. 1, holotype from the Auckland Mus., 86 mm.; figs. 2, 3 from 60-70 fms. off Eastern Otago, 91 mm. Fig. 4, holotype of *matai*

(Powell), Beach Harbour, Breaksea Sound, Fiordland. Fig. 5, *forma powelli* (Finlay), holotype from the Auckland Mus., 40-50 fms. off Whakatane, Bay of Plenty, 73 mm. (photos courtesy of A. W. B. Powell).



*niveum* (Brazier), and could be considered a synonym of that form just as well.

*Measurements (mm.)—*

length	width	no. whorls	
80.8	55.5	9	holotype of <i>mawsoni</i> Cotton

*Synonymy—*

- 1929 *Xenogalea spectabilis* Iredale, Records Australian Mus., vol. 17, no. 4, p. 178, pl. 38, fig. 6 (off Montague Id., New South Wales, 50-60 fms. Type in the Aust. Mus. no. C 57722).
- 1935 *Phalium spectabile* (Iredale), Bayer, Zoolog. Mededeel., Leiden, vol. 18, p. 111.
- 1945 *Xenogalea mawsoni* Cotton, Trans. Roy. Soc. South Australia, vol. 69, pt. 1, p. 168, pl. 12, figs. 1, 2 (120 mi. west of Eucla, Western Australia, 120 fms.). Type in the So. Aust. Mus. no. D 14201.

*Records*—WESTERN AUSTRALIA: 120 and 90 miles west of Eucla, 75-120 fms. (Cotton's *mawsoni*, 1945, p. 168). SOUTH AUSTRALIA: off Beachport (C. F. Kurtze, ANSP). VICTORIA: Portland; Lorne; Lakes Entrance (all ANSP); Port Fairy; Queenscliff (both Nat. Mus. Vict.). NEW SOUTH WALES: off Forster (Joy Kerslake, coll.); off Montague Id., 50-60 fms. (Iredale, 1929, p. 179). TASMANIA: off Hobart (Joy Kerslake, coll.).

**New Zealand Forms**

**forma *finlayi* (Iredale, 1927)**

(Pl. 13, fig. 16; pl. 155)

*Range*—Off the east coasts of South and North Islands, New Zealand; 15 to 80 fathoms.

*Remarks*—This name was applied by Iredale to the specimen identified as *stadialis* Hedley by Finlay in 1924 (Trans. Proc. N.Z. Inst., vol. 55, pl. 52, figs. 3a-c) from 20 fathoms between Otago Heads and Waikouaiti, eastern South Island. The shell and other specimens associated with it are about 60 to 90 mm. in length, globose to somewhat elongate, thin-shelled, smooth-shouldered and colored a shining, yellow-brown or with a reddish brown stain. The type is without spiral lines at its base, but other specimens may have various incised lines. The early whorls are cancellate, later ones being mainly spirally incised. Outer lip of type thin and lacking denticles, but thicker specimens have them (*abernethyi* Dell, 1956). Iredale stated that *finlayi* "is easily separable from the Australian species [*stadialis* Hedley] by its more globose form." This is not a specific character in the *pyrum* complex, and I have before me several *finlayi* which are less globose than Australian specimens. The forma *finlayi* does not differ appreciably, and I retain it merely as a courtesy, so that New Zealand workers may refer to it in their ecologic studies. I consider *matui* (Powell, 1952) a dwarf form of *finlayi* with *pyrum* coloration. It was based upon a single live specimen found on intertidal mudflats in southwest South Island. Offshore trawling there would probably bring in other larger specimens.

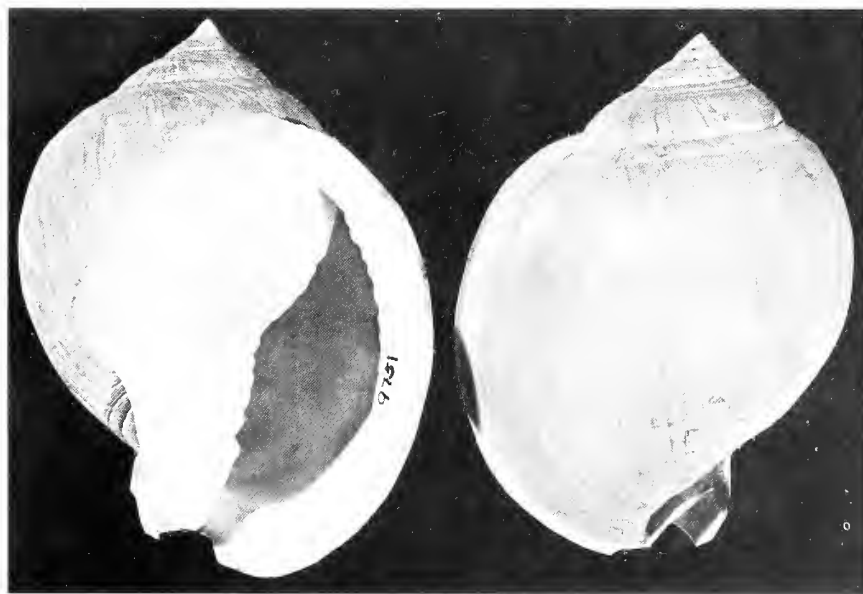


Plate 156. *Phalium* (*Xenophalium*) *pyrum* (Lamarck, 1822) forma *hamiltoni* Powell from 40 fathoms, off Castlepoint, New Zealand. Paratypes, M 9751 of *Xenophalium abernethyi*

Dell, 1956. Left fig.: 64 mm. in length. Other paratypes bear shoulder nodules.

*Synonymy*—

- 1924 *Cassidea stadialis* Hedley, Finlay, Trans. Proc. New Zealand Inst., vol. 55, p. 525, pl. 52, figs. 3a-c. (20 fms., between Otago Heads and Waikouaiti).  
 1927 *Xenogalea finlayi* Iredale, Records Australian Mus., vol. 15, p. 342 (refers to Finlay's figs. 3a-c).  
 1952 *Xenophalium* (*Xenogalea*) *matai* Powell, Records Auckland Inst., vol. 4, no. 3, p. 78, pl. 35, fig. 6 (Beach Harbour, Breaksea Sound, Fiordland, New Zealand; intertidal mudflat, alive. Type in the Auckland Mus.).

*Records*—NEW ZEALAND: 70 fms., off Castlepoint (Dom. Mus.); 50-60 fms., off Otago Heads, Dunedin (Auck. Mus.; ANSP); 15-16 fms., east of Damuru (Dom. Mus.); 80 mi. NNE of Dunedin, 45-75 fms. (John Black, ANSP and USNM).

**forma powelli (Finlay, 1928)**

(Pl. 155, fig. 5)

*Range*—East coast of North Island, New Zealand; 40 to 70 fathoms.

*Remarks*—Related to *finlayi*, but “with a short spire and traces of nodulation on the shoulder; color less tawny, more olive in shade; shell less inflated, especially basally” [and] 73 x 52 mm. Intergrades of *powelli* and other named and unnamed New Zealand forms are before me. The type is figured by Finlay (1926, pl. 20, fig. 64).

*Synonymy*—

- 1926 *Phalium* n. sp. (*pyrum* auct.), Finlay, Trans. Proc. New Zealand Inst., vol. 57, explanation to plate 20, fig. 64 (40 fms. off Whakatane).

1928 *Xenogalea powelli* Finlay, loc. cit., vol. 59, pt. 2, p. 247, (40-50 fms., off Whakatane, Bay of Plenty).

*Records*—NEW ZEALAND: NORTH ISLAND: 40-50 fms., off Whakatane, Bay of Plenty (Auck. Mus.); 70 fms., off Castlepoint (Dom. Mus.); off eastern coast of Great Barrier Id.; beach at Maunganui; Opotiki; Waikanae Beach, Cook Strait; 40-50 fms., off Cape Campbell, Marlborough (ex Powell, 1928, p. 639).

**forma hamiltoni (Powell, 1928)**

(Pl. 156)

*Range*—East coasts of South and North Islands, New Zealand; 40 to 100 fathoms.

*Remarks*—Powell (1928, p. 635) characterizes this form as “shell globose, spire low, spire and base striated; suture margined by grooves; entire absence of nodules; no colour pattern.” The type is 71 x 55 mm. and came from 60 fathoms off Cape Campbell, Marlborough, where other intergrading forms are found. Dell's *abernethyi* combines the features of this forma and *harrisonae*, and I arbitrarily dispose of it in the synonymy of this forma, since the shell is globose and spirally incised. *X. abernethyi* has a more thickened lip and hence weak denticles on the inner edge. Its shoulder may be smooth or with weak nodules, as demonstrated by the paratype series kindly loaned to me.



Plate 157. *Phalium pyrum* (Lamarck, 1822). Left: holotype of *Cassis zeylanica* Lamarck. 75.4 mm. [South Africa]. Right:

holotype of *Cassis pyrum* Lamarck. 63.2 mm. [South Australia]. (both in the Mus. Geneva).

*Synonymy*—

- 1928 *Xenophalium hamiltoni* Powell, Trans. Proc. New Zealand Inst., vol. 59, p. 639, pl. 75, figs. 25, 26 (off Cape Campbell, Marlborough, in about 60 fms.; in Dom. Mus., Wellington).  
 1956 *Xenophalium (Xenogalea) abernethyi* Dell, Dominion Museum Bull. no. 18, Wellington, p. 87, pl. 12, figs. 119, 122 (off Castlepoint, east coast Wellington, in 40 fms.; type in Dom. Mus. M9752).

*Records*—NEW ZEALAND: 60 fms. and 40 fms., off Cape Campbell; 40 fms., off Castlepoint; 65-70 fms., off Wellington, V.U.Z. sta. 44; 100 fms., off Palliser Bay (all Dom. Mus.).

**forma harrisonae (Powell, 1928)**

(Pl. 13, fig. 10)

*Range*—Southern South Island and Stewart Island, New Zealand (Recent); Castlecliff, North Island (Pliocene).

*Remarks*—This is the well-calcified *forma* from the waters around Stewart Island in the south of New Zealand. Because the shell is thick, denticles on the inside of the outer lip and rugae on the columella are generally moderately developed. The heavy shell is globose, with or without shoulder nodules, and sometimes with a well-developed color pattern. Shells with an extra varix in the last whorl are not infrequent. Spiral incised lines are present below the suture in most but not all specimens. Basal grooves may be absent in some Mason's Bay specimens. Equally heavy shells sometimes occur in more northern localities, but are generally given other names.

*Synonymy*—

- 1928 *Xenophalium harrisonae* Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 640, pl. 75, figs. 27, 28 (Mason's Bay, Stewart Island).

*Records*—NEW ZEALAND: STEWART ISLAND: Mason's Bay (Auck. Mus.; Dom. Mus.; MCZ; ANSP). SOUTH ISLAND: off mouth of Waiiau River, Te Waewae Bay (J. H. Sorensen, Dom. Mus.).

*Fossil records*—UPPER PLIOCENE: Castlecliff, Wanganui, North Island (Powell, 1928, p. 640).

**forma wanganuiense Powell, 1928**

*Range*—Upper Pliocene, North Island, New Zealand.

*Remarks*—I have not seen this shell, but from its description and illustration it appears to be one of the smooth-shouldered, globose *pyrum* types still found living along the east coast of North Island. It closely resembles *hamiltoni*

and *abernethyi*, and seems more likely to be an element which came in from Australia during the Upper Pliocene (or Pleistocene?), rather than being a descendant of the certainly quite different *fibratum* (Marshall and Murdock, 1920) of the Lower Pliocene.

*Synonymy*—

- 1928 *Xenophalium wanganuiense* Powell, Transactions New Zealand Institute, vol. 59, p. 637, pl. 76, fig. 36 (Wanganui, Upper Pliocene, Castlecliff, New Zealand, Holotype in N.Z. Geol. Survey).

**Phalium pyrum subspecies  
royanum (Iredale, 1914)**

(Pl. 13, fig. 9; pl. 158-159)

*Range*—New South Wales, Australia, northern New Zealand and the Kermadec Islands.

*Remarks*—The shells of this subspecies are large for members of the *Xenophalium* group, ranging in length from 4 to 5-1/2 inches. The degree to which the plicae on the columella are developed is quite variable, and denticles on the inside of the lower third of the outer lip may be absent or present. This species is obviously closely related to the *pyrum* group, differing only in the rate at which the whorls descend (causing an acute, raised spire) and the amount of shell matter deposited by the mantle (causing a thick, well-noduled shell). I would not be surprised to learn if shells were found in the Kermadecs and northern New Zealand which had lower spires and fewer nodules. In that event, it might be necessary to consider this as an ecologic warm water form of *pyrum*. Several specimens, all of rather uniform shape, have been brought up in crayfish pots from 10 to 20 fathoms off the Cavalli Islands, Whangaroa, and it certainly seems best to consider *royanum* as a subspecies. *Xenophalium ericanum* Powell from Whangaroa is a smooth-shouldered intergrade. Doubtlessly, other intermediates will be collected in the future. The large size of these shells is probably due to ecologic conditions.

A light-weight form (*forma hedleyi* Iredale, 1927) lives off the coast of New South Wales, and it may be the original source of the New Zealand stock of *royanum*. It is not as heavily noded as many of the New Zealand specimens, and it bears the color patterns of other Australian forms of *pyrum*, such as *stadiale* Hedley. It is a matter of choice as to whether *hedleyi* should be considered as a subspecies allied to the Australian forms or allied to the *royana* complex



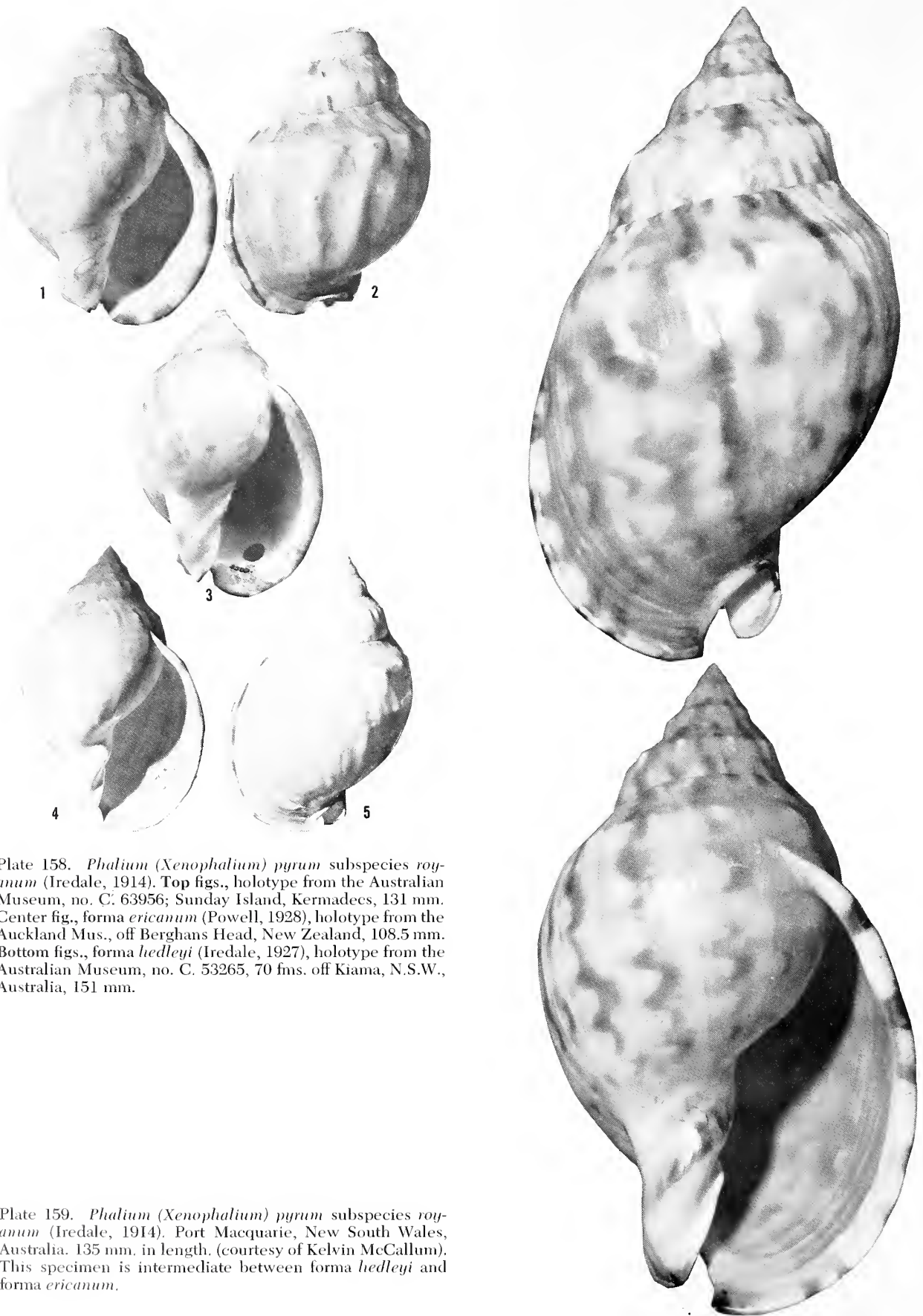


Plate 158. *Phalium* (*Xenophalium*) *pyrum* subspecies *roy-anum* (Iredale, 1914). Top figs., holotype from the Australian Museum, no. C. 63956; Sunday Island, Kermadecs, 131 mm. Center fig., forma *eric anum* (Powell, 1928), holotype from the Auckland Mus., off Berghans Head, New Zealand, 108.5 mm. Bottom figs., forma *hedleyi* (Iredale, 1927), holotype from the Australian Museum, no. C. 53265, 70 fms. off Kiama, N.S.W., Australia, 151 mm.

Plate 159. *Phalium* (*Xenophalium*) *pyrum* subspecies *roy-anum* (Iredale, 1914). Port Macquarie, New South Wales, Australia. 135 mm. in length. (courtesy of Kelvin McCallum). This specimen is intermediate between forma *hedleyi* and forma *eric anum*.

which occurs in northern New Zealand and the Kermadecs. I prefer the latter course in order to show the probable close relationship and migratory connections between the New South Wales and New Zealand warm water subspecies.

**Description**—Adult shell 101 to 135 mm. (4 to 5½ inches) in length, solid, rather heavy and with an elevated spire. Color light-tan with 4 to 5 light-brown spiral bands on the body whorl, and with irregular, axial flames which are especially dominant in the whorls of the spire. Nuclear whorls 2½ smooth and tan. First 2 or 3 postnuclear whorls with numerous microscopic threads and incised lines. The center thread becomes larger and finally develops into a spiral series of small knobs. Shoulder of body whorl with 1 or 2 rows of moderately large nodules, but these may be reduced in size or be absent in some specimens (*forma ericanum*). Outer lip is a thickened, smoothish varix, sometimes denticulate on the inner margin. This varix is crossed by 6 dark-brown to mauve-brown, narrow color bands. True umbilicus slightly to moderately open; false umbilicus sealed. Parietal wall lightly glazed. Columellar shield thick, whitish and rounded. Columella bears 5 to 7 low, short, slanting plicae with the lowest or most anterior one being the largest. Tip of recurved siphonal canal stained with dark brown. Channel behind siphonal canal is moderately shallow and fairly wide. Operculum unknown.

#### Measurements (mm.)—

length	width	no. whorls	
151.0	84.5	—	Poor Knights Islands, fide Powell, 1967, p. 187
135.0	83.0	—	Kermadecs, fide Powell, 1928, p. 641
131.5	90.0	4+	holotype of <i>royana</i>
122.0	72.0	—	Cavalli Id., fide Powell, 1928, p. 641
110.5	69.0	8+	Flat Id., Cavalli Ids., N.Z.
101.0	61.0	—	Cavalli Ids., fide Powell, 1928, p. 641

#### Synonymy—

- 1914 *Cassidea royana* Iredale, Proceedings Malacological Society London, vol. 11, p. 179, text fig. (Sunday Island, Kermadec Group).  
 1927 *Xenophalium royannum* Iredale, Iredale, Records Australian Museum, vol. 15, p. 333; 1928, Powell, Trans. and Proc. New Zealand Inst., vol. 59, p. 641; 1967, Powell, Records Auck. Inst. Mus., vol. 6, no. 3, p. 187.

**Types**—The type locality is Sunday Island, Kermadec Islands. Collected by Mr. Roy Bell. The holotype of *royana* Iredale, 1914, is in the Australian Museum, no. C 63956, and was not presented to the Canterbury Museum, Christchurch, New Zealand, as Iredale suggested (1914, p. 180).

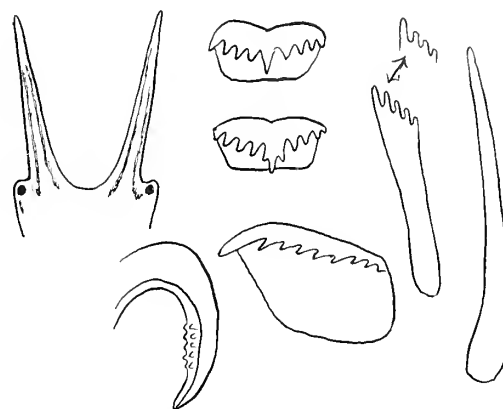


Plate 160. *Phalium (Xenophalium) pyrum* (Lamarek). Head, penis and radulae of New Zealand form from a depth of 40 meters.

**Records**—NEW ZEALAND: NORTH ISLAND: in crayfish pots, 20 fms., off Cavalli Islands near Whangaroa (W. La Roche, Auck. Mus.); 10 fms., off Flat Id., Cavalli Islands (Bollons, Dom. Mus. N.Z.); living on sand, 150 ft. depth, northwest end of Tawhiti Rahi, Poor Knights Islands (Powell, 1967, p. 187). KERMADEC ISLANDS: (T. F. Cheeseman, 1887, Auck. Mus.); Sunday Id. (Roy Bell, Aust. Mus.). See also *forma ericanum* (Powell, 1928).

#### *forma ericanum* (Powell, 1928)

(Pl. 158, fig. 3)

**Range**—Northeast coast of New Zealand; 25 fathoms.

**Remarks**—Shells of this form are without the strong nodules of the typical race, *royannum*, found nearby. The shell is large and heavy with resulting denticles on the inside of the outer lip. The curious axial growth folds are also found in some specimens of typical *royannum*. The supposed specific characters originally recorded for *ericanum* appear at random in most *royannum*—like specimens found in this area of New Zealand, and I think it likely that this form and other intergrades will be found in the Kermadecs.

#### Measurements (mm.)—

length	width	no. whorls	
108.5	62.5	10	holotype of <i>ericanum</i>
98.5	62.0	—	paratype of <i>ericanum</i>

#### Synonymy—

- 1928 *Xenophalium ericanum* Powell, Trans. and Proc. New Zealand Inst., Wellington, vol. 59, p. 639, pl. 75, fig. 29; 1961, Powell, Shells of New Zealand, ed. 4, p. 93.

**Types**—The type locality is 25 fathoms off Berghans Head, 8 miles N.E. of Mangonui, N.E. New Zealand. Collected by Mr. Eric Sanderson. The holotype is in the Auckland Museum.

**Records**—Known only from the type locality.

**forma *hedleyi* (Iredale, 1927)**

(Pl. 158, figs. 4, 5)

*Range*—Off New South Wales; 70 fathoms.

*Remarks*—This rare, large, handsome form is characterized by its elevated spire, its almost absent columellar plicae, and the weakly shouldered whorls which bear small nodules, especially pronounced in the spire. Specimens may reach a length of 5-1/4 inches and be prettily colored with axial, zigzag flames of chestnut brown. The outer lip is not denticulate, although heavier specimens, not found as yet, would undoubtedly possess them. The floating veligers of this form may be capable of reaching northern New Zealand and be contributing to the colonies of *royanum* in the warmer waters of that island. From New South Wales I have seen forms somewhat similar to *hedleyi* which are not as large, have no nodules, but do have a slight shouldering on the body whorl. Gigantism in this group produces columellae with less developed plicae.

*Measurements (mm.)—*

length	width	no. whorls	
151	92	7+	holotype of <i>hedleyi</i> Iredale
135	79	8+	off Port Macquarie, N.S.W.

*Synonymy—*

1927 *Xenophalium hedleyi* Iredale, Records Australian Mus., 15, p. 333 (5 mi. off Kiama, New South Wales, in 70 fms. Type in the Aust. Mus. no. C 53265).

*Types*—The type locality is 70 fathoms, 5 miles off Kiama, New South Wales, Australia (collected by Captain J. W. Smith). The holotype is in the Australian Museum, Sydney, no. C 53265.

*Records*—NEW SOUTH WALES: 70 fms., off Kiama (type, Aust. Mus.); off Port Macquarie (Kelvin McCallum, coll.); off Cape Everard (Aust. Mus.).

***Phalium pauciruge* (Menke, 1843)**

(Pl. 161)

*Range*—Limited to southwestern Western Australia.

*Remarks*—Thanks to the careful work of Iredale, the identity and distinctiveness of this species is now clearly understood. Previously it had been confused by Bednall, Brazier, Verco, and evidently Cotton, with such forms of *pyrum* as *niveum* and *spectabile*. The Western Australian *pauciruge*, when in fresh condition, is

characterized by its very solid, heavy shell, by the 4 or 5 spiral rows of 9 to 14 squarish, orange-yellow blotches on the last whorl, by the small false umbilicus, by a single (rarely double) row of tiny tubercles high on the shoulder, by the usually denticulate inner edge of the outer lip, and by the cream to tan-saffron or yellow interior of the aperture. Dead specimens, more commonly found in collections, have a yellowish cast, have usually lost their spots, and may have a very slick, oily surface. The teeth on the outer lip may be obsolete or 6 to 24 and well-developed. Iredale (1927, p. 346) mentions that an umbilical perforation is present, but I have seen this in only one of 40 specimens examined. The groove at the anterior end of the columellar shield is not always present nor characteristic of this species.

Care should be taken not to confuse this species with a heavy, glistening, spotted form of *pyrum*, sometimes dredged off New South Wales. The eastern dwarf differs in being more globose, with a spiral subsutural line with smaller spots, and without denticulations on the outer lip. Iredale (1929, p. 346) reported a *pauciruge*-like shell from New South Wales, but later (1929, p. 178) named it *spectabile* [a form of *pyrum*].

I examined Salmon's (1948) specimens of "*paucirugis*" and found them to be *pyrum* (Lamarck). However, one of his "*nivea* Brazier" from Australia is a true *pauciruge* (Menke).

*Habitat*—Dredged in 10 fathoms of water. Dead specimens are sometimes washed up on beaches.

*Description*—Adult shell 34 to 69 mm. (1-1/4 to 2-3/4 inches) in length, ovate, very solid, glistening white to yellowish, with 4 to 6 spiral series of squarish, light orange-yellow blotches, and smoothish except for a row of minute, low knobs on the shoulder. Nuclear whorls bulimoid, 2-1/2, white, opaque, smooth and shiny. First three postnuclear whorls strongly, but microscopically, decussate with 6 to 10 spiral threads and numerous axial threads. Last 2 or 3 whorls slightly angular at the shoulder where there are numerous small whitish knobs or tubercles. Last third of last whorl usually without these knobs. Spire moderately to well produced, and without former varices. Outer lip with a strong, smooth recurved, brown-to-mauve-spotted varix. Suture minutely impressed. Columella white and with a dozen or so weak or strong spiral lirae which do not extend across the swollen enamel-white, heavy columellar shield. The



latter is rolled back and partially obscures the false umbilicus which is moderately deep. True umbilicus absent or a minute perforation. Inside of aperture light-tan to saffron-yellow. Outer lip with 6 to 24 weakly or strongly developed axial lirae. Color of body whorl whitish to yellowish with 6 spiral rows of squarish orange-yellow blotches, the row just below the suture and the one just above the narrow siphonal gutter being

sometimes obscure or absent. Operculum smooth and light-tan.

*Measurements (mm.)*—(all from Western Australia)

length	width	no. whorls	
69.0	44.2	6+	Cotteslow, near Perth
65.9	44.3	6+	Swan River, ex Lovell Reeve (Nat. Mus. Vict. F23k99)
61.1	39.6	8	Beagle Island, north of Perth
34.0	23.0	6+	Near Albany

*Synonymy*—

1843 *Cassis paucirugis* Menke, *Molluscorum Novae Hollandiae*, Hanover, p. 23, no. 107 (in *litore occidentalis* [Australia]); 1844, *Zeitschr. Malak.*, p. 60 (Swan River Colony); 1848, Reeve, *Conch. Icon.*, vol. 5, sp. and fig. 19 on pl. 8.

1916 *Cassidea paucirugis* Menke, Hedley, *Jour. Roy. Soc. Western Australia*, vol. 1, 1916, p. 47 (W. Australia).

1927 *Xenogalea paucirugis* (Menke), Iredale, *Records Australian Mus.*, vol. 15, p. 345, pl. 31, fig. 2 (Western Australia).

*Types*—I have been unable to locate Menke's type in Germany. However, a specimen in the Zoologisk Museum in Copenhagen, presumably sent to Mörch by Menke, and labelled "*paucirugis* Mke" conforms to our interpretation of this species. The type locality is "in *litore occidentalis* [Australia]". In 1844, Menke further limited it to Swan River (Perth), Western Australia.



Plate 161. *Phalium* (*Xenophalium*) *pauciruge* (Menke, 1843). Perth, Western Australia. Length of top shell: 58 mm.

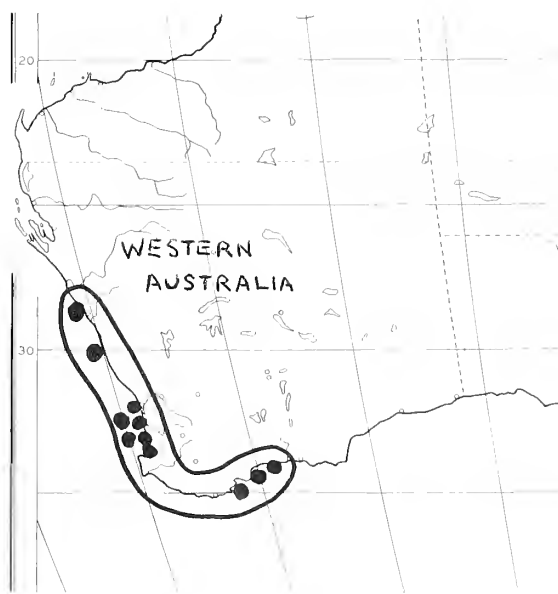


Plate 162. Geographical distribution of *Phalium* (*Xenophalium*) *pauciruge* (Menke).

**Records**—ALL WESTERN AUSTRALIA: Beagle Id., 160 mi. north of Perth (Poole brothers, West. Aust. Mus.); Swanbourne and Cottesloe beaches, Perth (West. Aust. Mus.); dredged off Pt. Gregory, 50 mi. north of Geraldton (A. Whitworth, ANSP); off Kwinana, near Perth (ANSP); Success Bank, Cockburn Sound, near Perth (B. R. Wilson, West. Aust. Mus.); off Rottnest Id., near Perth (Nat. Mus. Victoria); Bremer Bay (West. Aust. Mus.); King George Sound (Nat. Mus. Victoria); Cheyne Bay, 60 mi. east of Albany (B. R. Wilson, West. Aust. Mus.); 1 mi. offshore, Mandurah (E. Nickels, coll. 1964).

### *Phalium radiatum* (Tate, 1889)

**Range**—Miocene of Murray Desert, New South Wales and South Australia.

**Remarks**—This species was evidently based upon one specimen which has curious axial ribs. The shell appears to be related to the *pyrum* (Lamarck) group, but it is with some hesitation that I place it in *Xenophalium*. I doubt if it is allied to the Recent *Casmaria erinaceus* [torquata Reeve], as suggested by Tate. The original description reads:

“Shell globosely ovate, spire of moderate length, acuminate, ending in a small pullus [nucleus] of one and a half smooth convex whorls.

“Whorls four, excluding pullus, convex, but interrupted by a broadish concave depression in front of the marginal rib at the anterior suture.

“Posterior whorls ornamented by straight, rather crowded, slender costae, which terminate behind at the ante-sutural depression.

Last whorl ventricose, contracted at the base, and concavely depressed in front of the suture, from which it is separated by a nodosely-crenulated band; ante-sutural zone with three or four spiral threads. Median portion ornamented with angular, slightly elevated, moderately curved costae (about 24); at first slender and crowded, but become stronger and more widely separated with the revolution of the whorl, and are absent in the last-fourth. The costae are interrupted on the shoulder by three inconspicuous angulations; otherwise the surface anterior to the sutural zone is without spiral ornament, except some obscure lines at the base.

“Aperture ovate; outer lip thickened, margin plain, slightly ascending on the penultimate whorl. Columella convex, its surface without granulations, with fine slender revolving plaits; a small tubercle at the posterior angle of the aperture. Length, 23; breadth, 15; length of aperture, 18 mm.”

### *Synonymy*—

1889 *Semicassis radiata* Tate, Trans. and Proc. Royal Soc. South Australia, vol. 11, p. 168, pl. 8, fig. 3 (in a well sinking, Murray Desert); 1903, Dennant and Kitson, Records Geol. Survey Victoria, vol. 1, no. 2, p. 34; 1941, Ludbrook, Trans. Royal Soc. South Australia, vol. 65, p. 100; 1958, Ludbrook, *ibid.*, vol. 81, p. 53 (Tareena, N.S.W. and Adelaide, South Australia).

### *Phalium thomsoni* (Brazier, 1875)

(Pl. 13, figs. 14, 15; pls. 163-164)

**Range**—Southeastern Australia from Bass Straits north to northern New South Wales; northern New Zealand.

**Remarks**—This distinctive species occurs on the continental shelf in the same areas as the deep-water forms of *pyrum* (i.e., *stadiale* and *spectabile*). In rare instances there may be a superficial resemblance in shell characters, but *thomsoni* is characterized by the left edge of its columellar shield which is strongly and concavely arched (instead of being straight), by the reticulate sculpturing on the early post-nuclear whorls, by the spiral incised lines or weak, rounded, low, wide threads on the base of the shell, and by the 5 fairly broad chestnut spots on the posterior edge of the varix (instead of 5 to 8 spots). *P. thomsoni* is quite variable



Plate 163. *Phalium* (*Xenophalium*) *thomsoni* (Brazier, 1875). New Zealand specimen from 40 fathoms, off Cuvier Island, Bay of Plenty. (courtesy of A. W. B. Powell).

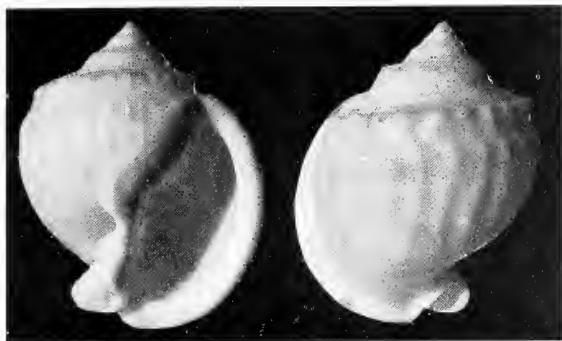


Plate 164. *Phalium* (*Xenophalium*) *thomsoni* (Brazier, 1875). Holotype of the dwarf form, *Xenogalea thomsoni palinodia* Iredale, 1931, in the Australian Museum no. C. 57793 from Sydney Harbour, Australia. 44 mm. in length. (photos courtesy of D. F. McMichael).

in the degree of nodulations on the shoulder. Usually, there are two spiral cords bearing about two dozen rounded nodules, but in some specimens the nodules are more numerous, smaller and axially oblong. A specimen from 60 fathoms off Broken Bay, N.S.W., is almost smooth, except for spiral threads at the shoulder. Large shells, 3 inches in length are lighter in weight and less sculptured. Dwarfed and heavy, well-noduled specimens were given the name *palinodium* (Iredale, 1931).

The nearest relative to *thomsoni* is *whitworthi* Abbott, 1968, from Western Australia. The latter differs in being very strongly corded and in having a higher spire, but otherwise is similar. No morphological or geographical intermediates have as yet been found.

**Description**—Adult shell from 36 to 88 mm. (about 1½ to 3½ inches) in length, globose, moderately thin- to thick-shelled, spire short, with noded shoulders, and colored with tan-brown and irregular reddish brown spots. Whorls 8 or 9. Nuclear whorls bulimoid, relatively large, 4 smooth, tan or whitish, and followed by finely cancellate postnuclear whorls. Body whorl usually shouldered by 1, 2, or 3 spiral cords which may be finely or coarsely beaded or noded. Base of body whorl bears 4 to 12 spiral, incised lines. True umbilicus open and deep; false umbilicus at the base of the columella is closed or slit-like. Left edge of columella strongly arched. Right or inner edge bears numerous, irregular plicae. Outer lip recurved, usually smooth, but may bear a few to many minute teeth. Tip of siphonal canal bears a very weak, brown splotch. Color spots on body whorl irregular in size and usually occurring in 3 to 5 spiral rows. Operculum and soft parts unknown.

#### Measurements (mm)—

		no.	
length	width	whorls	
88.0	68.2	8	large; New South Wales (J. Kerslake)
70.0	49.6	8	average; off Eden, New South Wales
56.0	39.0	8	holotype of <i>thomsoni</i> Brazier
44.0	35.0	—	holotype of <i>palinodia</i> Iredale
36.2	25.3	7	small; southern New South Wales

#### Synonymy—

- 1875 *Cassis* (*Casmaria*) *thomsoni* Brazier, Proc. Linn. Soc. New South Wales, vol. 1, p. 8 (45 fms., 5 mi. due east of Sydney Heads, Australia, "Challenger". Type in Aust. Mus. no. C 111612).
- 1889 *Cassis thomsoni* Brazier, Whitelegge, Journ. Proc. Roy Soc. New South Wales, vol. 23, p. 257.
- 1902 *Cassidea pyrum* var. *thomsoni* Brazier, Hedley, Mem. Australian Mus., vol. 4, p. 341, pl. 35, figs. 2, 3.
- 1927 *Xenogalea thomsoni* (Brazier), Iredale, Records Australian Mus., vol. 15, p. 342, pl. 32, fig. 6, 7.
- 1931 *Xenogalea thomsoni palinodia* Iredale, Records Australian Mus., vol. 18, p. 215 (Sydney Harbour, Australia. Type in Aust. Mus. no. C 57793).
- 1964 *Xenophalium* (*Xenogalea*) *thomsoni* (Brazier), Powell, Records Auckland Inst. and Mus., vol. 6, no. 1, p. 13, figs. 4, 5.

**Records**—TASMANIA (Northern part, fide Macpherson and Gabriel, 1962, p. 149). VICTORIA: off Cape Everard (Nat. Mus. Vict.). NEW SOUTH WALES: 25-100 fms., off Eden (Neil F. Buckland, ANSP); off Montague Id. (Aust. Mus.); 30-70 fms., off Cape Green (Aust. Mus.); off Ulladulla (J. Kerslake, coll.); 60 fms., off Botany Bay (Nat. Mus. Vict.); Sydney Harbour and Broken Bay (Aust. Mus.); 30 fms., off Port Stephens (A. D'Attilio, coll.); Forster (Joy Kerslake, coll.). QUEENSLAND: 60-100 fms., off Moreton Bay, near Brisbane (Joy Kerslake, ANSP). NEW ZEALAND: (all fide A. W. B. Powell, 1964, p. 13.) 40 fms., off Cuvier Id., Bay of Plenty (A. and E. Turner, coll.); 30 mi. north of Mangonui; 20-29 fms., off Stephenson Id., Whangaroa; Marsden Point, Whangarei Heads.

**Fossil records**—None known.

#### *Phalium whitworthi* new species, Abbott

(Pls. 165-168)

**Range**—Known only from off Western Australia.

**Remarks**—In recent years fishermen have been bringing to light a distinctive cassid which appears to be undescribed. I take pleasure in naming it after Arch R. Whitworth of Geraldton, who first sent me specimens in 1962. *P. whitworthi* is related to *thomsoni* (Brazier) of eastern Australia, and subsequent collecting in southern Australia might possibly reveal the presence of intergrades. *P. whitworthi* is characterized by 12 to 14 very strong, squarish, beaded, spiral cords on the body whorl. As in *thomsoni*, the umbilical side of the columella is strongly and concavely arched. The two species are similar in range of coloration and in the variability of





Plate 165. Holotype of *Phalium (Xenophalium) whitworthi* Abbott new species from Abrolhos Islands, Western Australia. Australian Museum no. C. 63957.

the small teeth on the glossy, reflexed outer lip. One of 7 specimens seen has a former varix on the penultimate whorl.

**Description**—Adult shell from 60 to 83 mm. (about 2-1/3 to 3 inches) in length, solid, globose, strongly corted, tan with sparse, brown spots, and with a deep umbilicus. Whorls 8. Nuclear whorls 4, bulimoid, smoothish, and yellowish white. First 2 or 3 postnuclear whorls cancelled by axially slanting threads and numerous,

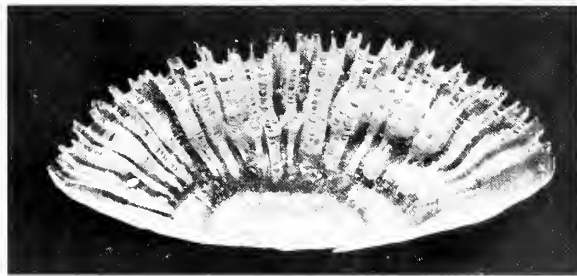


Plate 166. Operculum of *Phalium (Xenophalium) whitworthi* Abbott, new species. 20 mm. Western Australia. Paratype.

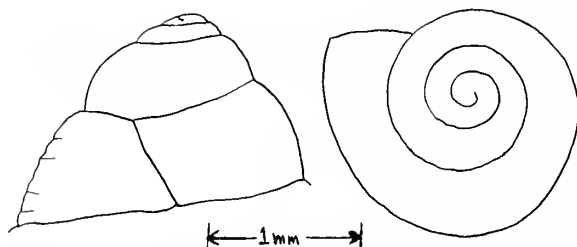


Plate 167. Nuclear whorls of *Phalium (Xenophalium) whitworthi* Abbott new species. Recent, Western Australia.

irregular spiral threads. The whorls in the spire bear 4 to 5 strong, square, spiral cords. Body whorl with 12 to 14 cords which bear numerous, axially elongate, whitish beads. Color of shell tan to cream with a few, small, irregularly-placed, chestnut to reddish brown spots. Posterior edge of reflected varix bears 5 or 6 single or paired, brown spots. Tip of siphonal canal with a small bar of brown. True umbilicus round and deep; false umbilicus open. Interior of aperture white and channelled by the ribs on the last whorl. Outer lip undulating or marked by about 15 to 20 small teeth, some of which may be clumped in pairs. Columella rugose, white, glossy, and concavely arched on its left edge next to the umbilicus. Operculum fan-shaped and strongly, radially sculptured.

#### Measurements (mm.)—

length	width	no.	
		length	whorls
83.0	56.2	9	paratype; Jack Fearnly collection.
81.0	56.0	9	holotype, Aust. Mus. C 63957
77.6	51.0	9	paratype, near West Wallaby Id.
68.1	43.5	8	paratype, Beagle Id. (W. Aust. Mus.)
60.0	43.1	8	paratype, North Id. (ANSP 272396)

**Types**—The type locality is the Abrolhos Islands, Western Australia. The holotype has been deposited in the Australian Museum, rather than the Academy of Natural Sciences, since this is an Australian species. Paratypes are in

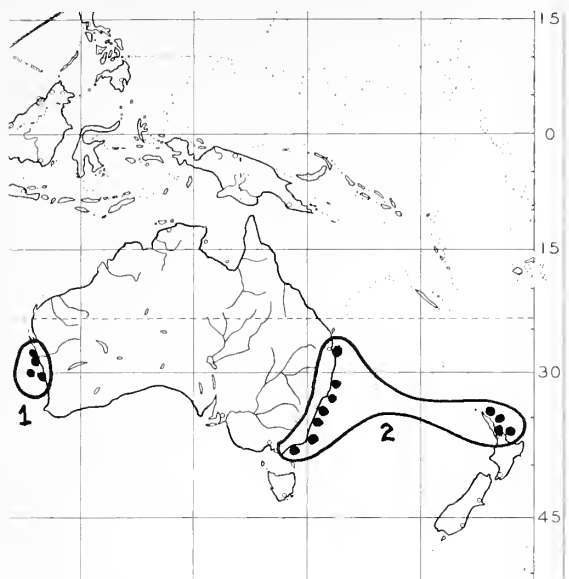


Plate 168. Geographical distribution of *Phalium* (*Xenophalium*) *whitworthi* Abbott (fig. 1 in Western Australia) and *Phalium* (*Xenophalium*) *thomsoni* (Brazier) in eastern Australia and northern New Zealand, fig. 2.

ANSP no. 272396 and the Western Australian Museum no. 159-62.

**Records**—WESTERN AUSTRALIA: 20-40 fms., off Beagle Island (Poole Brothers, West. Aust. Mus.); crayfish pots, North Island, Abrolhos Ids. (A. R. Whitworth, ANSP); crayfish pots, near West Wallaby Id., Abrolhos Ids. (A. Kalnins); near Geraldton (West. Aust. Mus. no. 163-62). All paratypes.

### *Phalium inornatum* (Pilsbry, 1895)

(Pl. 13, fig. 6; pl. 169)

**Range**—Central Japan to the South China Sea.

**Remarks**—This species is moderately common off the coasts of Honshu Island in depths from 20 to 50 fathoms, but to the south, in the China Sea, it has been collected in 170 fathoms. It is reminiscent of *Phalium* (*Semicassis*) *bituberculosum* (von Martens) off the East African coast in that it has a tendency toward beading on the shoulder and a slight tendency toward pustules on the columellar shield. In general shape, coloration and parietal characters it resembles some Australian species, such as *pyrum* (Lamarck). In Japan, it may be confused with *glabratum bulla* Habe, 1961, but *inornatum*'s color spots, smoother columellar shield, the finely noduled shoulder, and the brown-tipped columella will separate it from *bulla*. *Phalium inornatum* is variable in shape (sometimes being smooth-shouldered), and color (yellowish, rosy-brown or whitish), and in the degree to which the true umbilicus is open. The outer lip has a few dark-brown, usually wide bands, while in *bulla* they

are numerous, evenly-spaced and light mauve-brown.

**Description**—Adult shell oblong, solid, with a conic, somewhat elevated spire, shouldered above, weakly umbilicate, with a weakly dentate outer lip, and colored cream with weak, yellowish brown spots. Nuclear whorls 3-1/2, bulimoid, glossy, and white. Post-nuclear whorls in spire shouldered and bearing numerous, rough, spiral threads, the largest sometimes bearing numerous

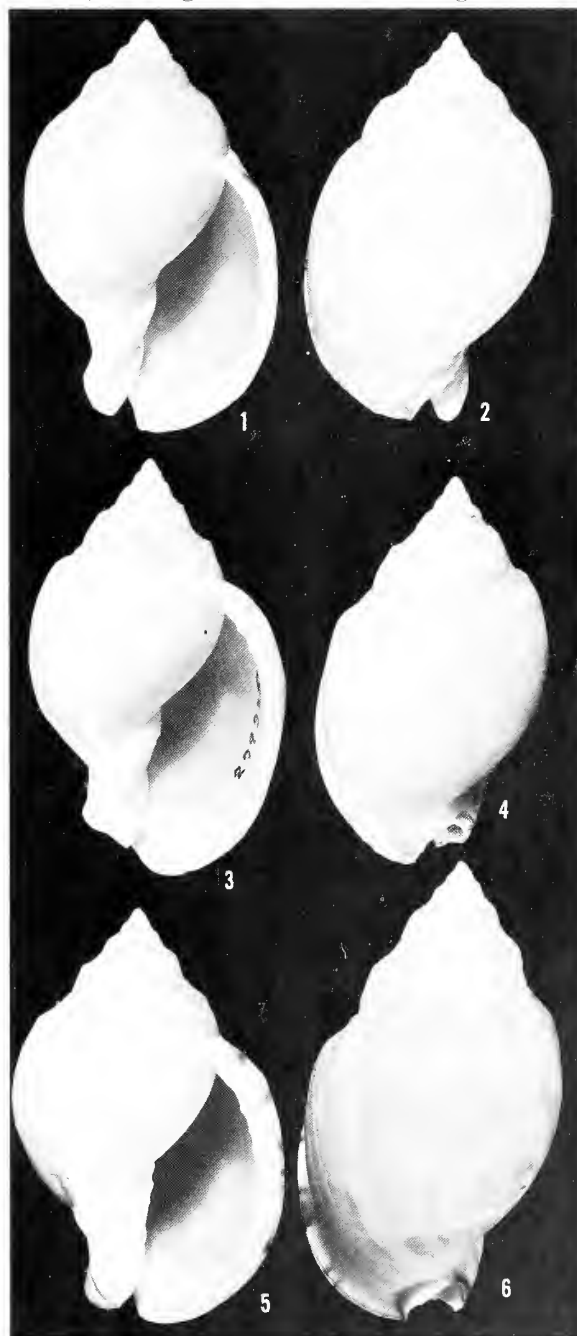


Plate 169. *Phalium* (*Xenophalium*) *inornatum* (Pilsbry, 1895). Figs. 1, 2, smooth form, off Kyushu Island, Japan. 51.3 mm. Figs. 3, 4, noduled form, off Kyushu Island, Japan. 52.5 mm. Figs. 5, 6, both off Tosa, Japan, 48 and 60 mm.

small nodules. Body whorl smooth, except for the finely noded shoulder and for 5 to 8 fine, wavy, incised lines at the base. Color cream to yellowish with 5 or 6 spiral rows of indistinct, irregular, small yellowish brown blotches. Outer lip thick, glossy, reflected and with 5 broad, broken bands of dark-brown. Parietal wall lightly glazed. Columella shield smoothish, except for a swollen ridge in the middle, a raised spiral ridge at the base, and sometimes 3 to 7 small, obscure pustules on the lower half. Outer lip smooth or with a few poorly developed teeth. True umbilicus moderately open or sometimes almost sealed. False umbilicus usually sealed. Tip of siphonal canal black-brown. A fine raised thread runs back from the edge of the siphonal canal into the true umbilicus. Operculum light tan, thin, fan-shaped, with weak radial indentations and with numerous, fine, concentric growth lines. Soft parts unknown.

*Measurements (mm.)—*

length	width	no. whorls	
65.0	40.0	—	holotype, fide Pilsbry, 1895
56.0	32.6	8	large; off Tosa, Japan
51.6	34.6	8	average; Wakayama, Japan
41.3	26.2	8	small; Ise Bay, Mie Pref.

*Synonymy—*

- 1895 *Cassis achatina* var. *inornata* Pilsbry, 1895, Catalogue of the Marine Mollusks of Japan, Detroit, p. 49 (Japan).  
 ?1909 *Cassis achatina pyrum* Lam., Iwakawa, Cat. Jap. Moll. Tokyo Imperial Mus., pt. 1, p. 66 (Misaki). ?  
 1935 *Phalium (Xenogalea) labiatum* var. *inornata* Pilsbry, Bayer, Zoolog. Mededeel., vol. 18, p. 109 (Kii, Japan).  
 1947 *Semicassis (Xenogalea) inornata* (Pilsbry), Furukawa and Kubota, A Catalogue of Moll. Shells from Fukui Pref., ed. 2, p. 12, no. 259; 1961, Oyama, The Molluscan Shells, Resources Exploitation Institute, Tokyo, vol. 5, *Semicassis* plate 1, fig. 4-6.  
 1961 *Xenogalea inornata* (Pilsbry), Habe, Coloured Illustrations of the Shells of Japan, Osaka, vol. 2, p. 44, pl. 21, fig. 12 (50 to 100 meters, Japan).

*Records—JAPAN:* 20 fms. off Tosa, Shikoku Id., Ise Bay, Mie Prefecture, Honshu Id.; Wakayama, Honshu Id.; Tokyo Bay, Honshu Id.; off Kyushu Id.; Kii; Sagami Bay, Honshu Id. (all A. R. Cahn coll'n., ANSP). *CHINA:* 170 fms., coral sand, northeast of Pratas Id., South China Sea. Albatross Station 5306 (USNM).

**?*Phalium gradiferum***

(Cossmann and Pissarro, 1909)

*Range—*Lower Eocene of Sind, India (Ranikot series).

*Remarks—**P. gradiferum* appears to be a juvenile and imperfectly preserved form of *Xenophalium*, possibly related to *P. phillipsi* d'Archiac

and Haime. The latter was reported by Cossmann and Pissarro (1909, p. 37) from a nearby locality in the Ranikot series. The shell is peculiar in having a narrow but deep channel at the suture. Vredenburg (1928, p. 41) proposed a new section name, *Eocasmaria*, for this species which I have synonymized with *Xenophalium*. The original description of the species reads:

"Small (22 mm. in length), short, globose; spire feebly prominent, forming successive steps, approximately conical in general outline; four convex spire-whorls separated by deep channelled sutures. The sutures are surrounded by a projecting thread followed by a narrow, slightly excavated band, which becomes more accentuated as the shell increases in size. Body-whorl very large, constituting almost the whole shell, partly spherical, with a rounded base which is excavated only at the neck where it bears a series of concentric threads rendered subgranular by the intersection of lines of growth interrupted against the screw-like keel formed by the successive growths of the basal notch revolving round the neck in a flattened zone. Aperture broad, oval, deeply notched anteriorly; outer lip feebly slanting, without a thickened rim; columella excavated, with a few wrinkles behind the spiral keel limiting the swelling that surrounds the neck; columellar margin constituting a thick callus posteriorly, indistinct at the level of the wrinkles."

*Synonymy—*

- 1909 *Cassidea (Casmaria) gradifera* Cossmann and Pissarro, Memoirs Geol. Survey India, Palaeontologia Indica, new ser. vol. 3, no. 1, p. 38, pl. 6, fig. 8-10 (lowermost zone of Upper Ranikot, underscarp of Jakhmari peak, Sind, India; Lower Eocene).  
 1928 *Cassidea (Semicassis) (section Eocasmaria) gradifera* C. and P., Vredenburg, ibid., new ser., vol. 10, no. 4, p. 41.

***Phalium moniliferum* (Sowerby, 1846)**

*Range—*Tertiary of Chile.

*Remarks—*This species resembles the thick, knobbed, living *Phalium* of South Africa. I have only seen the type, which is in the British Museum Department of Paleontology no. G 26364. It measures 38.7 mm. in length and 28.0 in width.

*Synonymy—*

- 1846 *Cassis monilifer* Sowerby, 1846, in Darwin's Geological Observations on South America, vol. 3, appendix, p. 260, pl. 4, fig. 65 (Navidad, Chile).  
 1887 *Cassis monilifera* Sowerby, Philippi, Die Tertiären und Quartären Versteinerungen Chiles, Leipzig, p. 68, pl. 8, fig. 1 (Lebu and Llancahue, Chile; Tertiary).



**Phalium labiatum (Perry, 1811)**

This cool-water species has one of the most interesting distributions of all the cassids, for it consists of a series of races ringing the continents of the Southern Hemisphere. Its most isolated and most uniform subspecies, *iheringi* (Carcelles), occurs in northern Argentina, Uruguay and southern Brazil. In South Africa, it appears to be radically polymorphic, probably due to constant hybridization with *Phalium pyrum* (Lamarck). The probable hybrid or ex-

treme ecologic form in South Africa received the name of *zeylanicum* (Lamarck). In Australia and New Zealand, the typical subspecies, *labiatum* (Perry), occasionally exhibits characters which strongly suggest hybridization with the *pyrum* of those waters. The Australian "hybrid" received the name *insperatum* (Iredale), the New Zealand one, *collacteum* (Finlay).

A profound influence on the morphology of the shell by ecologic conditions may be the alternate explanation for this puzzling array of forms. A specimen I have illustrated here from

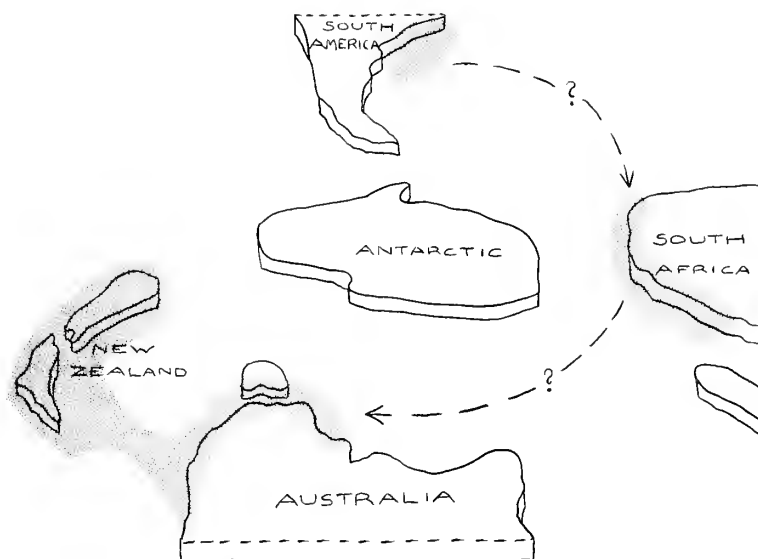


Plate 170. Circumpolar distribution of *Phalium* (*Xenophalium*) *labiatum* (Perry) showing direction of hypothetical

migration, by means of ocean currents, of free-swimming larvae.

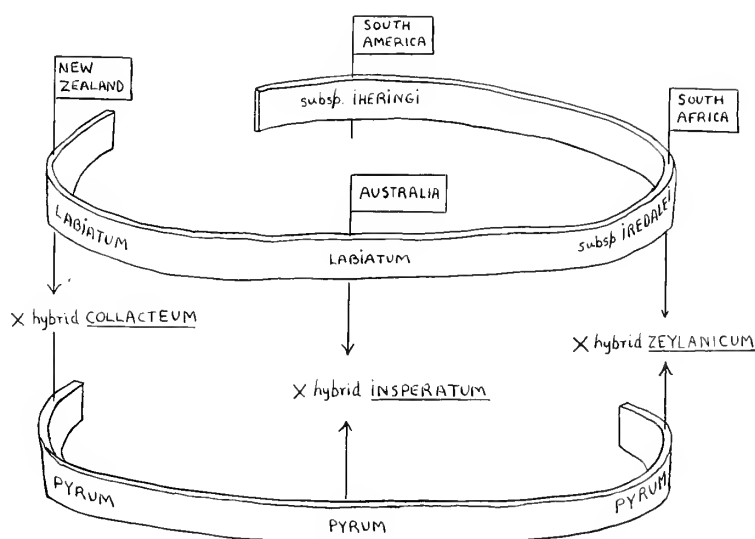


Plate 171. Circumpolar distribution of two species of cold-water *Phalium* (*Xenophalium*) showing the hypothetical origin of hybrid forms in New Zealand (*labiatum* × *pyrum* = *col-*

*lacteum*) and in South Africa (*labiatum iredalei* × *pyrum* = *zeylanicum*).

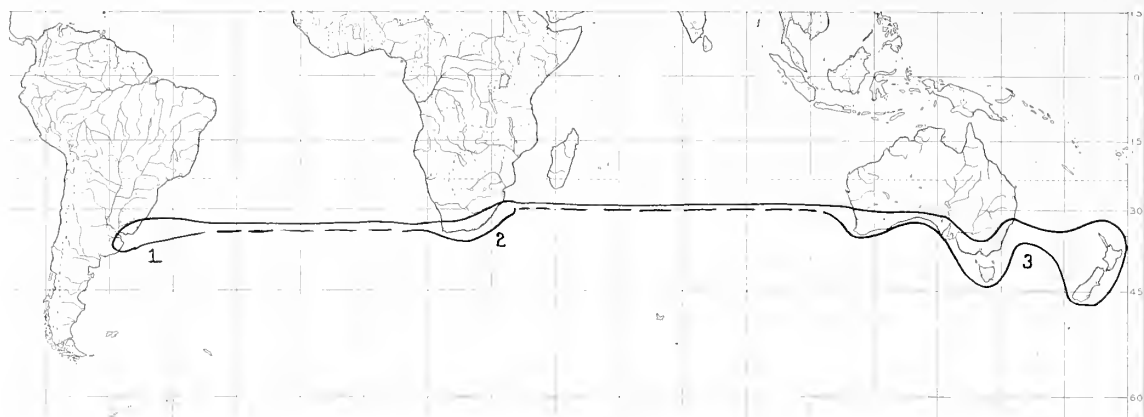


Plate 172. World distribution of *Phalium labiatum* (Perry). 1, subspecies *iheringi* (Carcelles, 1953); 2, subspecies *iredalei* (Bayer); 3, typical subspecies *labiatum* (Perry).

New Zealand shows typical “*collecteum*” characters in the first 5 whorls, but in the last whorl there is seen a sudden change to typical *labiatum* characters. These changes may possibly be associated with the temperature, motion and depth of the water. That some genetic control exists is suggested by the purely *labiatum*-like qualities of South American shells where no specimens of *pyrum* are known to exist. In the absence of rearing experiments under various ecologic conditions, I am treating this complex in the conventional manner in order to keep the nomenclature relatively simple. I have observed that there is no sexual polymorphism, at least in the South African forms.

The most significant difference between the South African and Australian-New Zealand subspecies is the presence, in the latter, of about 3 to 7 very weak lirae on the inner central area of the columella. The lirae are absent or very slightly developed in South African specimens. This difference also exists in the forms of *pyrum*, again the South African representative having a smooth central columella. This geographical peculiarity in one character is expressed in other characters in certain Australian species (see remarks under *Phalium* (*Semicassis*) *whitworthi*, *thomsoni* and *glabratum* subspecies *angasi*).

Although there are some specimens of *labiatum* from each area that are difficult to distinguish from each other, there are subtle differences and locally dominant characters which I believe justify recognizing three geographical subspecies:

**Australia-New Zealand:** *labiatum* subspecies *labiatum* (Perry, 1811). Small plicae usually present on columella's inner edge. Parietal

wall (when not covered with white glaze) has axially coalescing brown blotches and arrows. Channel behind siphonal canal usually narrow. Shell of noduled form, not very heavy, and with 1, rarely 2, rows of weak nodules on the shoulder. Small brown spots prominent just below the sutures, especially in the spire. Nuclear whorls usually pink or tan, rarely white.

**South America:** *labiatum* subspecies *iheringi* (Carcelles, 1953). Small plicae usually present on columella's inner edge. Parietal wall has 3 spiral rows of large, arrow-shaped brown blotches. Channel behind siphonal canal usually broad. Shell of noduled form, not very heavy, and with 1 row of nodules on the shoulder. Brown spots below suture large and diffused. Nuclear whorls always (?) white.

**South Africa:** *labiatum* subspecies *iredalei* (Bayer, 1935). Small plicae usually absent on columella's inner edge. Parietal wall (when not covered with thick, white glaze) has 3 or 4 poorly or strongly defined rows of brown spots or arrow-shaped blotches. Channel behind siphonal canal usually broad in the heavy noduled “hybrid” form, and usually somewhat narrow in the typical, smooth, light-weight form. Shell of noduled form, usually very heavy, and with 1 to 3 rows of heavy, pointed nodules on the shoulder. Brown spots below suture moderately large and weakly colored. Nuclear whorls pink, tan or white.

In all races the true umbilicus may be moderately open and deep or almost closed. The false umbilicus may be sealed or minutely indented or slit-like. All races vary in shape from oblong-ovoid to somewhat globose. The outer lip may be smooth or more commonly with up to

24 small teeth. The Australian specimens are usually rather heavily denticulate, especially on the lower half of the lip. The operculum is horny, thin, light-brown, semi-circular, with faint radial indentations, with very fine, concentric growth lines, about  $\frac{1}{3}$  the length of the aperture.

**Phalium labiatum subspecies  
labiatum (Perry, 1811)**

(Pl. 13, fig. 17-21)

**Range**—Portland, Victoria, to southern Queensland; northern New Zealand; Norfolk Island.

**Remarks**—The typical subspecies of *labiatum* is quite common in New South Wales, but is uncommon to rare elsewhere in its range. Evidently the waters of Tasmania and southern New Zealand are too cold for its survival, and most of Queensland is too warm. It has evidently come northward from New Zealand to Norfolk Island, but, to date, has not been recorded from the Kermadecs. New Zealand specimens do not differ significantly from those living in New South Wales, and they are probably very recent arrivals. Both the smooth shouldered form and that with one or two rows of weak nodules (forms *insperatum* Iredale, 1927 and *collactenum* Finlay, 1928) live in the same places. The shell is variable in coloration, sculpture and shape. I have seen two specimens which for the first 6 whorls were pale in color and with shoulder nodules, but which turned into the darkly blotched, smooth-shouldered form in the last whorl. There is no geographical cline present in these various ecologic forms, and statements by various authors that globosity, thickness of shell, development of columellar teeth, color patterns, etc. are significant characters in this species are not to be taken seriously. The variability of *labiatum* in New Zealand led Powell (1928, pp. 631-633) to interpret some shells as being the result of hybridization of *labiatum* and *insperatum*. Considering the variability found within a single specimen, and allowing a normal amount of variability in the radula, I think that hybridization between two such "species" is not a reasonable explanation. I would, however, not overlook the possibility that there has been some retrogression or hybridizing with the local *pyrum*.

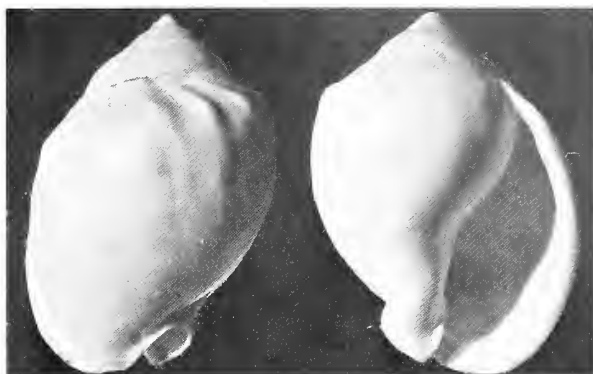


Plate 173. *Phalium* (*Xenophalium*) *labiatum labiatum* (Perry, 1811). Syntypes (cotypes) of *Xenogalca insperata* Iredale in the Australian Museum no. C. 53270 from Port Jackson, New South Wales, Australia. (photos courtesy of D. F. McMichael).

**Description**—Description and comparative remarks about this subspecies appear above. Adults vary from  $1\frac{1}{3}$  to  $3\frac{1}{4}$  inches in length.

**Habitat**—*S. labiatum* occurs from the littoral zone below the low tide mark to depths of about 50 fathoms. It is occasionally washed up onto beaches.

**Measurements (mm.)—**

length	width	no. whorls	
82.6	52.1	7+	large; Western Point, Victoria
81.4	52.0	8+	large; Hauraki Gulf, New Zealand
69.0	48.0	—	type of <i>collactea</i> Finlay
56.0	41.0	—	type of <i>insperata</i> Iredale
54.5	37.2	7	lectotype of <i>achatina</i> Lamarck
51.8	32.0	7+	elongate; Collaroy Beach, N.S.W.
42.8	30.0	7+	globose; Collaroy Beach, N.S.W.
34.0	24.0	6+	small; Woolli, New South Wales

**Synonymy—**

- 1811 *Cassidea labiata* Perry, Conchology, London, pl. 34, fig. 1 ("South Seas").
- 1816 *Cassis achatina* Lamarck, Le Liste, Paris, p. 3, Tableau Encyclopédique et Méthodique, vol. 1 (pt. 23), pl. 407, figs. 1a, b. (Nova Holl.); 1822, Anim. sans Vert., vol. 7, p. 226 ("les mers de la Nouvelle Hollande"); 1835, Kiener, Coquilles Vivantes, Cassis, p. 37, pl. 13, fig. 24.
- 1840 *Cassidea achatina* [Lamarck], Swainson, Treatise Malacology, London, p. 299.
- 1848 *Cassis achatina* Lamarck, Reeve, Conch. Icon., vol. 6, Cassis, pl. 10, figs. 28a, b. (South African locality erroneous; both shells are Australian).
- 1873 *Semicassis* (*Casmaria*) *achatina* Lam., Brazier, Proc. Zool. Soc. London, for 1872, p. 838, no. 5 (Port Jackson, found under stones; Merimbula, etc.).
- 1902 *Cassidea labiata* Perry, Hedley, Proc. Linn. Soc. New South Wales, vol. 27, p. 27.
- 1918 *Phalium labiatum* Perry, Hedley, Jour. Roy. Soc. New South Wales, vol. 51, p. M.67.
- 1927 *Xenogalca labiata* (Perry), Iredale, Records Australian Mus. vol. 15, pp. 347-349, pl. 31, fig. 1; 1962, Macpherson and Gabriel, Marine Molluscs of Victoria, Melbourne, p. 149, fig. 178.



- 1927 *Xenogalea insperata* Iredale, *ibid.*, p. 349, pl. 31, fig. 8 (type locality here designated: Port Jackson, New South Wales).
- 1928 *Xenogalea collectea* Finlay, Trans. and Proc. New Zealand Inst. Wellington, vol. 59, p. 246 (Opotiki, Bay of Plenty, New Zealand). Refers to *ibid.*, vol. 57, pl. 20, figs. 62, 63 (1926).
- 1928 *Xenophalium labiatum* (Perry), Powell, Trans. and Proc. New Zealand Inst., Wellington, vol. 59, p. 640, figs. 15-17.
- 1928 *Xenophalium insperatum* (Iredale), Powell, *ibid.*, p. 641, fig. 19.
- 1945 *Xenogalea inseparata* Iredale, Cotton, Trans. Royal Soc. South Australia, vol. 69, no. 2, p. 251 (error for *insperata* Iredale).

**Types**—Perry's type of *labiatum* is probably lost. Among Lamarck's specimens of *achatinum* in the Museum de Genève is one which was figured by Kiener (1835, pl. 13, fig. 24). We designate it as the lectotype of *achatinum* Lamarck, 1816. It measures 54.5 x 37.2 mm. and has 7 whorls. The type locality is Australia. The type of *insperatum* Iredale from Port Jackson, New South Wales, is in the Australian Museum, Sydney, no. C.53270. The type of *collecteum* Finlay is in the Auckland Institute and Museum and the type locality is Opotiki, Bay of Plenty, New Zealand.

**Records**—AUSTRALIA: VICTORIA: Portland (Miss Niven, 1916); San Remo; Western Port (all Nat. Mus. Vict.). NEW SOUTH WALES: Wonboyn Beach, Disaster Bay (Joy Kerslake, coll'n.); 50 fms., off Eden (Neil F. Buckland, ANSP); La Perouse; Vacluse; Bottle and Glass Rocks; Collaroy; Manly; Narrabeen; all near Sydney (all ANSP); Long Reef, near Sydney, (R. T. Abbott, MCZ); off Port Stephens (G. Thornley, ANSP); Port Macquarie (B. Kaspiew, ANSP); Nambucca Heads (Nat. Mus. Vict.); off Tweed Heads (ANSP); off Clarence River (Nat. Mus. Vict.). QUEENSLAND: Southport (Nat. Mus. Vict.); Caloundra (Aust. Mus.). NEW ZEALAND: Ahipara, Ninety Mile Beach; Opotiki, Bay of Plenty (both A. W. B. Powell, ANSP); Kemp's Beach, Pakiri, Jauraki Gulf (V. Orr, 1961, ANSP); Mt. Maunganui, Bay of Plenty (Dom. Mus. N.Z.); Omaha, Hauraki Gulf (Dom. Mus. N.Z.); Smugglers Bay, Whangarei Heads; Tauranga Harbour; Tryphena, Great Barrier Island, 10 fms.; Muriwai Beach, West Coast (all Powell, 1928, p. 641). NORFOLK ISLAND: (Iredale, 1927, p. 348).

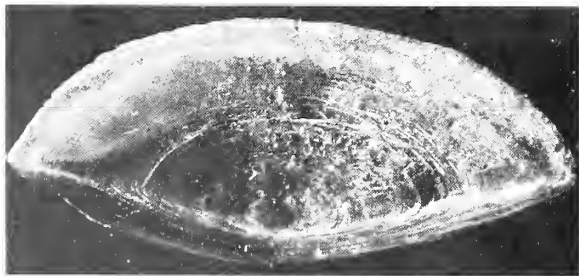


Plate 174. Operculum of *Phalium* (*Xenophalium*) *labiatum* subspecies *iredalei* (Bayer, 1935). South Africa. 20 mm.

### *Phalium labiatum subspecies iredalei* (Bayer, 1935)

(Pl. I3, figs. 1-5)

**Range**—Cape Province to Natal, South Africa.

**Remarks**—Typical specimens of this smooth-shouldered, darkly-colored, rather small subspecies differ from typical *labiatum labiatum* (Perry) of Australia in lacking the small spiral lirae or plicae on the inner central part of the columella. Atypical forms (*forma zeylanicum* Lamarck) are very heavy, with strong nodules on the shoulder, and may have bluish white spots on the body whorl.

In South Africa this subspecies is extraordinarily variable and, in my opinion, is an example of introgression or hybridization with the probably deeper water and rarer *Phalium pyrum* (Lamarck). This hybrid swarm seems to occur along the entire South African shores from Cape Town to Durban, Natal. Numerous intergrades are found at most localities which connect the light-weight, smooth *iredalei* and the larger, heavier, knobbed hybrid *iredalei* X *pyrum* (Lamarck's *zeylanica* and von Martens' *intercedens*). Nothing is known about the actual habitats of these forms, although the few authenticated lots indicate that *pyrum* and some heavy forms are found well offshore in 40 to 50 fathoms. Both forms are thrown up on many South African beaches in rather large quantities, but do not live in the intertidal zone so far as I know. Barnard (1951, p. 87) says the living soft parts are "cream-coloured, the sides of the foot deepening to orange, with a bright orange edge, and the tentacles are yellow with two black stripes." There are several shell forms all showing intergradation. Below I outline a few of the more obvious ones:

**forma zeylanicum** (Lamarck)—Shell heavy, 40 to 90 mm. in length, globular, shoulder with 2 rows of prominent whitish nodules, those in the lower row being slightly smaller; last whorl faint yellow-brown with 3 or 4 spiral rows of squarish, faintly discernable bluish white spots; base of shell with 1 to 4 fine, spiral, incised lines; channel behind siphonal canal is fairly wide; early whorls white, but sometimes tan or pink. Columellar shield thick, glazed, usually white.

**forma intercedens** (von Martens)—Same as typical form, but with only one row of nodules on the shoulder.

**form tri-noduled**—Same as typical, but with a third row of nodules on the body whorl.

**forma** typical *iredalei* Bayer, 1935—Shell moderately heavy to light, 35 to 50 mm. in length, shoulder smooth but somewhat raised; color dark mauve-tan with 3 to 5 spiral rows of darker spots which are bordered anteriorly by an arrow-shaped white smear. Columellar shield weak and yellowish tan to taffy-brown. Channel posterior to the siphonal canal is narrow; early whorls usually pink or tan, rarely white.

**form** elongate—Same as *iredalei* but the shell is elongate (example: 35 x 20 mm.), and the body whorl has 6 spiral brown bands on top of which are numerous small white spots. (Resembles *Casmaria ponderosa uippouensis* Abbott).

**Measurements (mm.)—**

length	width	no. whorls	
92.3	71.5	7+	large; forma <i>zeylanica</i> ; Knysna
74.4	60.0	6+	holotype of <i>zeylanica</i> Lamarck
67.3	48.0	8	forma <i>intercedens</i> von Martens; Cape Town.
41.0	26.1	7+	typical <i>iredalei</i> Bayer; Port Alfred
22.0	14.5	6+	small; Jeffreys Bay

**Synonymy—**

- 1822 *Cassis zeylanica* Lamarck, Anim. sans Vert., vol. 7, p. 226, no. 18 (Ceylon); 1844, Deshayes, Anim. sans Vert., ed. 2, vol. 10, p. 33, no. 18; 1848, Krauss, Die Südafrikan. Mollusken, Stuttgart, p. 115, no. 2; 1835, Kiener, Coquilles Vivantes, vol. 8, Casques, pl. 13, fig. 26 (heavy, noded hybrid *labiatum* X *pyrum*).
- 1839 *Cassis zeylanica* Anton, Verzeichniss Conchyl. Samml., Halle, p. 94 (error for *zeylanica*).
- 1840 *Cassidea zeylanica* Lam., Swainson, Treatise Malacology, London, p. 299 (error for *zeylanica*).
- 1848 *Cassis pyrum* Lamarck, Reeve (in part), Conch. Icon., vol. 5, Cassis, pl. 11, fig. 29c only; 1915, Bartsch, Bull. 91, U.S. Nat. Mus., p. 95.
- 1848 *Cassis achatina* Lamarck, Krauss, Die Südafrikan. Mollusken, Stuttgart, p. 115, no. 2; 1951, Beginner's Guide S. Afr. Shells, ed. 2, p. 87, pl. 9, figs. 15, 16.
- 1869 *Cassis ceylanica* Lamarck, Paetel, Moll. Syst. et Catalogue, Dresden, p. 39 [error].
- 1880 *Cassis ceylanica* Lam., von Martens, in Möbius' Beiträge zur Meeresfauna Ins. Mauritius und Seychellen, p. 263 [error for *zeylanica* Lam.].
- 1892 *Cassis achatina* Lamarck, Sowerby, Marine Shells of South Africa, London, p. 23.
- 1901 *Cassis ceylanica* Paetel, Tate and May, Proc. Linn. Soc. N.S.W., pt. 3, p. 444.
- 1903 *Cassis pyrum* Lam., von Martens, Wiss. Ergebn. Gastropoden deutschen Tiefsee-Exped., "Valdivia" vol. 7, pt. A, p. 54, 56, note 12.
- 1903 *Cassis pyrum intercedens* von Martens, *ibid.*, pp. 54, 56, note 12 (South Africa). [one row of nodules].
- 1932 *Cassis achatina craticulata* Euthyme, Turton, Marine Shells of Port Alfred, South Africa, Oxford, p. 112, no. 806. Not *craticulata* Euthyme, 1885.
- 1932 *Cassis zeylanica* Lamarck, Turton, *ibid.*, no. 807 (error for *zeylanica*); 1915, Bartsch, Bull. 91, U.S. Nat. Mus., p. 95.
- 1932 *Cassis zeylanica nivea* Brugnière, Turton, *ibid.*, no. 808 (error for *nivea* Brazier, there being no *nivea* Brug.)
- 1935 *Phalium (Xenogalea) labiatum* var. *iredalei* Bayer, Zoolog. Mededcel., vol. 18, p. 109 (Port Elizabeth, South Africa). [smooth form].

1935 *Phalium pyrum* var. *zeylanica* Lamarck, Bayer, *ibid.*, p. 110.

**Types**—The type of *zeylanicum* Lamarck, 1822, is in the Museum de Genève in Switzerland. The type locality of Ceylon is obviously erroneous. The shell probably came from near Cape Town, possibly Muizenberg, in False Bay. Bayer's type of *iredalei* is in the Rijksmuseum in Leiden. The type came from "South Africa" and paratypes from Port Elizabeth. I did not locate von Martens' type of *intercedens*, but it may still be in the Zoological Museum in East Berlin.

**Nomenclature**—Although Bayer proposed his *iredalei* as only a variety, his name is nomenclatorially available. Lamarck's 1822 name, *zeylanicum*, is based, in my opinion, upon a hybrid form and we use it in that sense as a name for the heavy, noded *labiatum* X *pyrum* shells. Should anyone subsequently show or believe that the South African forms are one variable species, then Lamarck's name would have to be employed, with *iredalei* being reduced to a **forma** name.

**Records**—SOUTH AFRICA: CAPE PROVINCE: Cape Town (ANSP); Muizenberg Beach, False Bay (Helen Boswell, ANSP); Salt Vlei Beach, Klein River (V. Orr, 1955, ANSP); Cape Agulhas (V. Orr, 1955, ANSP); Stillbaai, Riversdale District (MCZ); Knysna (Helen Boswell, ANSP); Jeffreys Bay (A. C. van Bruggen coll'n., ANSP; MCZ); Port Elizabeth, Algoa Bay (ANSP; MCZ; USNM); Port Alfred (E. K. Jordan, ANSP; MCZ; USNM); East London (ANSP; MCZ); Coffee Bay, Transkei (V. Orr, 1955, ANSP); NATAL: Durban (rare; accurate data?) (H. C. Burnup, Natal Mus.).

***Phalium labiatum subspecies  
iheringi* (Carcelles, 1953)**

(Pl. 175)

*Range*—Northern Argentina and southern Brazil.

*Remarks and Description*—This uncommon cassid is dredged offshore in waters of about 20 fathoms or more. The shell is brightly colored and characteristically has spiral rows of dark chestnut-brown, arrow-shaped blotches, which are bordered on their anterior concave sides by an opaque-white spot. The background color is yellowish cream. The thickened outer lip has 5 groups of mauve brown stripes, and has a few weak denticles on the lower, inner edge. The true umbilicus is fairly large and very deep, but

the false umbilicus is slit-like or sealed. Some specimens are elongate, others globose, and may have a smooth or weakly noduled shoulder. Nuclear whorls 3, smooth, bulimoid, and white. Operculum very similar to that of *labiatum labiatum*.

*Measurements (mm.)*—

length	width	no. whorls	
76.4	44.0	9	large; off Angra dos Reis, Brazil
62.5	38.0	8	average; off Ilha Grande, Brazil
60.0	41.0	7	holotype of <i>iheringi</i>
55.6	38.3	7	globose; Cassino Beach, Brazil
54.0	35.1	8	small; Isla de Lobos, Uruguay
48.8	32.8	7	small; Dept. Rocha, Uruguay

*Synonymy*—

- 1927 *Cassid pyrum*, von Ihering, Die Geschichte des Atlantischen Ozeans, Jena, p. 168 (Rio Grande do Sul).  
 1953 *Phalium iheringi* Carcelles, Comunic. Zoologicas Museo Hist. Nat. Montevideo, vol. 4, no. 70, p. 5, pl. 2, figs. 7-10 (Mar del Plata, off Uruguay, 84 meters); 1966, Fontes, Neotropica, vol. 12, no. 37, pp. 38-40, 3 figs.  
 1960 *Semicassis achatina* Lamarck, Barattini and Ureta, La Fauna de las Costas Uruguayas del Este, Consejo Dept. Montevideo, p. 122, pl. 37.

*Types*—The type locality is Mar del Plata, Uruguay, 84 meters. The holotype is in the Museo de Historia Natural de Montevideo, no. 13805.

*Records*—BRAZIL: deep water off Ilha Grande (Tursch, A. R. Cahn coll'n., ANSP); 20 meters, off Angra dos Reis, Rio State (E. Rios, 1958, Mus. Oceanogr. Rio Grande); Cassino Beach, Rio Grande do Sul (E. Rios, 1960, Mus. Oceanogr. Rio Grande). URUGUAY: Departamento de Rocha; off Isla de Lobos (both Mus. Nac. Hist. Nat. Montevideo). ARGENTINA: Mar del Plata (J. Pozzi, 1936, Mus. Hist. Nat. Montevideo); off Mar del Plata, 84 meters, S. Lat. 37° 38'; W. Long. 56° 20' ("Undine", 1926, Mus. Hist. Nat. Montevideo); off Puerto Quequén, S. Lat. 39° 30' (E. M. Fontes, 1966, p. 38).

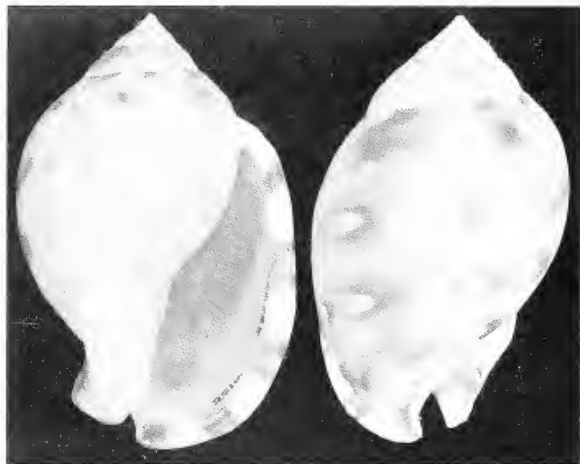


Plate 175. *Phalium labiatum* subspecies *iheringi* (Carcelles, 1953). Off Ilha Grande, Brazil. ANSP no. 283737. 62.5 mm.



### Genus *Casmaria* H. and A. Adams, 1853

Type: *Casmaria erinaceus* (Linné, 1758)

The genus *Casmaria* contains two tropical species whose small, glossy shells are characterized by an elongate shape, a columellar shield that is smoothish and poorly developed, and by one or two rows of sharp denticles on the outer lip. The false, or siphonal, umbilicus is closed. Both species exhibit two extreme shell forms, one

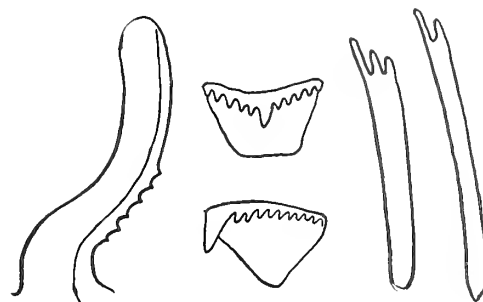


Plate 177. *Casmaria erinaceus* (Linné). Penis and radula from a Fiji specimen.

smooth and light-weight, the other strongly noduled and thick-shelled. Spiral sculpturing is virtually absent. The first two nuclear whorls are bounded at the suture by a microscopic dark-brown line. There is always a black-brown blotch on the siphonal canal. The operculum is fan-shaped to ovate, and bears three small reinforcement bars on the inner attachment side. The penis bears small sawtooth-like fleshy projections on one edge. The outer marginal radular tooth bears 2 or 3 long cusps.

A different genotype has been selected on three occasions, but the designation of *vibex* Linné (= *erinaceus* Linné, 1758) by Harris in 1897 is the first.

#### Synonymy—

- 1853 *Casmaria* H. and A. Adams, Genera of Recent Mollusca, vol. 1, p. 216. Type by subsequent designation by G. F. Harris, 1897, p. 200: *Buccinum vibex* Linné = *Casmaria erinaceus* (Linné, 1758). (Cossmann, 1903, p. 127 designated *pirum* Lam., and Cotton, 1945, p. 251, gave *ponderosa* Gmelin, 1791).  
 1888 *Casmeria* Jousseaume, Memoirs Soc. Zool. France, vol. 1, p. 190. Type by monotypy: *Cassis torquata* Reeve = *ponderosa* Gmelin, 1791.

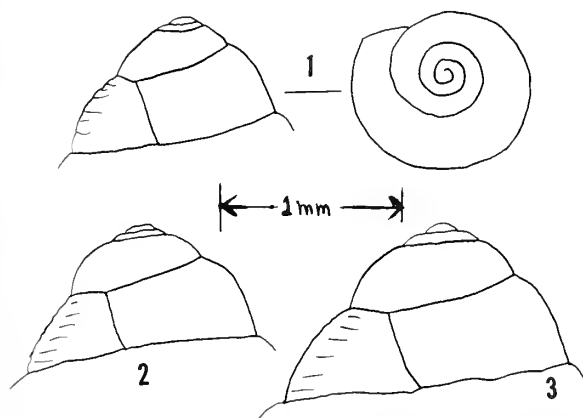


Plate 176. Nuclear whorls of *Casmaria*. Fig. 1, *ponderosa ponderosa* (Gmelin), Indo-Pacific. 2, *erinaceus* (Linné). 3, *ponderosa atlantica* Clench, Caribbean.

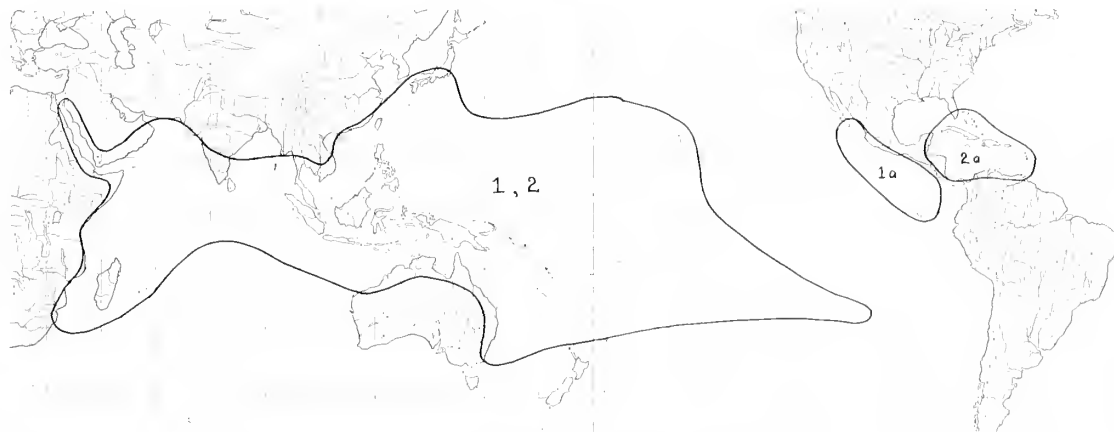


Plate 178. World distribution of the genus *Casmaria*. 1, *erinaceus* (Linné); 1a, *erinaceus* subspecies *vibexmexicana*

(Stearns); 2, *ponderosa* (Gmelin); 2a, *ponderosa* subspecies *atlantica* Clench.

*Casmaria erinaceus subspecies*  
*erinaceus* (Linné, 1758)

(Pl. 14, figs. 7-12)

*Range*—Red Sea and East Africa to Melanesia and Micronesia.

*Remarks*—This widely distributed, moderately common *Casmaria*, called *vibex* Linné by some workers, is quite variable in sculpturing and coloring, and in some cases, is difficult to distinguish from *ponderosa* (Gmelin). It occurs in two forms, often with intergrades, throughout most parts of its range—the typical, heavy, smaller *erinaceus* with nodules on the shoulder, and the smooth, usually larger, lighter form, *vibex* Linné.

In general, it differs from *ponderosa* in being more elongate, in having less globose whorls, in having 3 to 6 rather sharp prickles limited to the lower portion of the outer lip, in lacking square, brown spots both on the base of the body whorl and just below the suture, and in usually having axial rows of very tiny, brown “fly-speck” dots on the coarse growth lines of the body whorl. I have not seen these “fly-specks” in *ponderosa*.

In most cases, the very upper portion of the outer lip of *erinaceus* bears a varical brown spot which is about the level of the suture. In *ponderosa*, this area of the varix is white, so that the uppermost brown spot is well below the level of the suture. Small, heavy, noded specimens of both species are very similar, but in *ponderosa* there are two rows of prickles on the upper part of the outer lip, the inner row being the terminal ends of spiral lirae within the aperture.

The shells of *erinaceus* exhibit several interesting color forms which I believe are of genetic origin but which may be accentuated by environmental conditions. Some of them, because of their clinal nature and sometimes sporadic and geographically widespread occurrence, I consider as mere forms. With some hesitancy I recognize a Hawaiian and Polynesian subspecies, namely *kalosmodix* (Melvill). Its peculiarities and distribution are discussed below. The color form of axial, chestnut “zigzag stripes” (a single gene?) is commonest in the Philippines and Indonesia, but rarely occurs in northeast Australia, Melanesia, Micronesia, and in a few Hawaiian specimens of the subspecies *kalosmodix*. The color form bearing black-brown “fly-specks” occurs commonly throughout most of the species’ range, although, curiously, it is rare in the Philippine

area. A light-colored ecologic form is found associated with small atolls, while darker shells are associated with volcanic islands.

A subspecies, *vibexmexicana* (Stearns), occurs in the waters around southern Lower California, Mexico, and the Galapagos. Curiously, it resembles Indian Ocean specimens rather than those of the neighboring Polynesian subspecies.

*Description*—Adult shell 24 to 70 mm. (1 to 2-3/4 inches) in length, solid, glossy, elongate, with a smoothish, rounded columella, with strong, black-striped varix, with small prickles at the base of the varix, and without an umbilicus. Whorls 8. Nuclear whorls 3, the first very small and stained brown, the remaining two rapidly increasing in size, glossy, white and smooth. The whorl dips slightly, and forms a break in the growth just before the postnuclear whorls begin. Body whorl slightly rounded and with a smooth or a strongly noded shoulder. Color of shell whitish, cream or tan with or without 5 to 6 weak spiral bands of darker tan, brown or mauve-brown, and with or without darker brown axial, wavy streaks. Body whorl may have axial rows of microscopic black pin-points or “fly-specks” along former growth resting stages. Varix poorly to strongly developed, with 10 to 20 black-brown stripes. Rarely with a former varix. Base of outer lip with 4 to 6 tiny, sharp prickles. Columellar shield solid, white, rounded, with a slight spiral swelling in the middle, and with one strong lower and several weak upper spiral wrinkles disappearing within the aperture. Interior of aperture tan to brown. Umbilicus sealed over; false umbilicus absent. Siphonal canal short and at the base of the dorsal slot stained black. Operculum 1/4 the length of the aperture, corneous, thin, yellowish, fan-shaped and with weak growth lines.

*Measurements (mm.)—*

length	width	no. whorls	
69.5	40.8	8	large; Okinawa Id.
53.0	30.5	8	average; Zanzibar Id.
35.6	20.5	7	small; Samar, Philippines
24.0	14.1	7	smallest; Samar, Philippines

*Synonymy—*

- 1758 *Buccinum erinaceus* Linné, *Systema naturae*, ed. 10, p. 736, no. 390 (O. Americano); refers to Rumphius, pl. 26, fig. 7; Gualtieri, pl. 39, fig. 1.D; Argenville, pl. 17, fig. C; 1764, Linné, *Museum Lud. Ulricae*, p. 605, no. 255; 1767, Linné, 12 ed., p. 1199, no. 452. [noded form]; 1956, Dodge, *Bull. Amer. Mus. Nat. Hist.*, N.Y., vol. 111, art. 3, pp. 185-188.
- 1758 *Buccinum vibex* Linné, *Systema naturae*, ed. 10, p. 737, no. 392 (Jamaican); refers to Bonanni, pl. 152;

Rumphius, pl. 25, figs. E, 8, 9; Gualtieri, pl. 39, figs. L, F; Argenville, pl. 17, fig. H; Regenfuss, pl. 10, fig. 40 [smooth form]; 1764, Linné, Museum Lud., Ulricae, p. 606, no. 257; 1767, Linné, 12 ed., p. 120, no. 454; 1855, Hanley, Ipsa Linnaei Conchylii, London, p. 247.

1798 *Cassis denticulata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 32, no. 379; refers to Conchyl.-Cab., vol. 2, fig. 363. Not G. Fischer, 1807, which is *Quimalea pomum* Linné.

1798 *Cassis denticulata* Röding, Museum Boltenianum, Hamburg, pt. 2, p. 32, no. 379; refers to Conchyl.-Cab., vol. 2, fig. 363 [without prickles on outer lip].

1807 *Phalium edentulum* Link, Beschreibung der Natur-Samml., Rostok, pt. 2, p. 113; refers to Conchyl.-Cab., vol. 2, fig. 363 [without prickles on outer lip].

1857 *Cassis vibex* Linné, Küster, Systemat. Conchyl.-Cab., new series, vol. 3, pt. 1 b, p. 12, pl. 38, figs. 4-7, pl. 47, figs. 3, 4, pl. 51, figs. 5, 6.

1866 *Cassis vibex* var. *ventricosa* Rigacci, Cat. Conch. Collezione Rigacci, Rome, p. 44, no. 4326 (no locality). Nomen nudum.

1927 *Casuarina erinaceus* Linné and *vibex* Linné, Iredale, Records Australian Mus., vol. 15, p. 337.

1935 *Phalium (Casuarina) erinaceum* Linné, Bayer, Zoologische Mededeel., Leiden, vol. 18, p. 112.

**Types**—Specimens of both *vibex* and *erinaceus* are found in the Linnaean Society collection in London, each being properly marked by Linné, according to Hanley and to Dodge. *B. vibex* is the smooth shouldered form. I could not locate Link's type of *edentulum*, nor identify the Martini specimens in Copenhagen upon which Röding based his *denticulata* and *glabra*. I hereby designate Amboina, Indonesia, as the type locality for *erinaceus* Linné. Linné gave "Jamaica" as the type locality of *vibex*, but this was probably erroneous.

**Nomenclature**—Linné considered the smooth-shouldered and nodule-shouldered forms as separate species, *vibex* and *erinaceus* respectively. So did most early workers (Born, 1778; Gmelin, 1791; Bruguière, 1792; G. Fischer, 1807; Dillwyn, 1817, etc.)

Later workers considered them as varieties or synonyms of each other. Link (1807) was one of the first to state that *vibex* was merely a form of *erinaceus*. Ch. Bayer (1935, p. 112) and Iredale (1927, p. 337) pointed out that Linné's secondly proposed name, *vibex*, would have to be used as a variety or form name, if the two entities were to be lumped. Iredale lumped the smooth and noded forms of *ponderosa* (Gmelin), but apparently could not draw himself to do the same with *erinaceus* and *vibex*. I merge them without hesitancy. Hanley (1859, p. 247) and Reeve (1848) were largely responsible for the use of the name *vibex* in later popular books.

The name "*Buccinum Meles* Solander" was listed as a synonym of the noded *erinaceus* Linné in Dillwyn, 1817, p. 599 text. The name is invalid, as is "*pantherina* Solander" on the same page, which is *ponderosa* (Gmelin).

In describing his *Buccinum vibex*, Linné might well have had a mixture of the smooth form from the Indo-Pacific and a specimen of *Casuarina ponderosa atlantica* Clench, for he gave Jamaica as the type locality.

**Records**—(Also see accompanying distribution map)—MOZAMBIQUE: Porto Amelia (ANSP; MCZ). ZANZIBAR: Pwani Mchangani; outer reef at Kiwengwa (both A. J. Ostheimer, 3rd, 1957). INDIAN OCEAN IDS.: Agalega Id., 400 mi. north of Mauritius (ANSP); Gloriosa Id. (W. L. Abbott, USNM); Mauritius (MCZ); Mauome, Mauritius (Mauritius Inst.); Rodriguez Id. (Slater, Brit. Mus.); Cargados Id. (Mauritius Inst.; ANSP). MADAGASCAR: Sarodrano (R. W. Foster, MCZ); Nossi-bé (A. Chavane, ANSP); Nossi Iranja (Wm. Dodd, ANSP); Ile Ste. Marie (R. W. Foster, MCZ). SEYCHELLES: (M. B. Banks, MCZ; ANSP). RED SEA: Geb Zet (Berlin Mus.); Eilat, Gulf of Aqaba (A. Hadar, ANSP). MALDIVES: Mulaku Atoll (Peggy Carpenter, ANSP); Gafaro Id., north Malé Atoll (R. Jonklass, ANSP); South Nilandu Atoll (R. Robertson, 1964, ANSP). COCOS-KEELING: Pulo

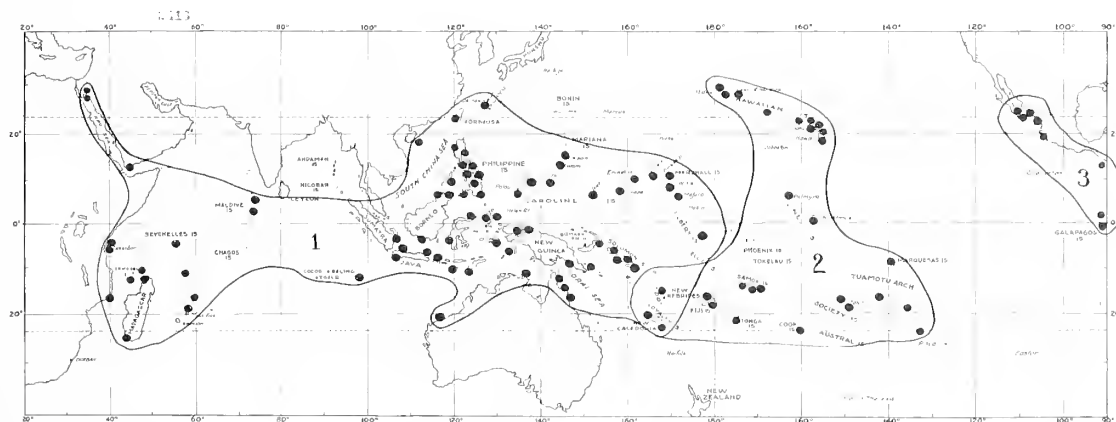


Plate 179. Geographical distribution of *Casuarina erinaceus* (Linné) and its subspecies. 1, typical subspecies *erinaceus* (Linné); 2, subspecies *kalosmodix* (Melvill) showing inter-

grades occurring in southeastern Melanesia; 3, subspecies *vibexmexicana* (Stearns) which more closely resembles the typical subspecies.



Beras (Gibson-Hill, USNM). RYUKYU IDS.: Metasaki, Okinawa Id. (Bernice Albert, ANSP); Ishigaki (A. S. Anderson, ANSP); Sakishima, Yaeyama Id. (A. A. Scott coll'n.). TAIWAN: Taihokusyü; Kiirun; Suo; Takao; Hoko (all Kuroda, 1941, p. 104). PHILIPPINES: numerous reef records from such islands as Luzon, Samar, Bohol, Cebu, Camiguin, Balabac, Cuyo, Mindanao, Sulu Archipelago (Sanga Sanga) (all ANSP); Basilan, Masbate, Negros, Jolo, Lubang (all USNM); Calapan (MCZ). NORTH BORNEO: Mandi Darrah Id.; Semporna. (Mary Saul, ANSP). INDONESIA: Japanoei, west Sumatra; Kei Id.; Banda Neira; Poelwe Hinako, near Nias; Lintido, Celebes (all Zoolog. Mus. Amsterdam); Ambon (Naturhist. Mus. Enschede); Basa Id., Gulf of Boni, Celebes; Taganak Id., Borneo (both USNM); Pulu Panaitan, west Java (L. J. Butot coll'n.); Banka Id. (east Sumatra); Madura; Boeroe Id., Sunda Ids.; Timor (all Rijksmus. Leiden); Geser Atoll, Ceram Id., (Paleo. Res. Inst. Ithaca); Tengah Id., off Boeroe and Morotai, Moluccas; Wodo Id., west of Halmahera Id.; Bali, Sunda Id.; Gorontalo, Celebes Id. (all MCZ); Kera, near Koepang, Timor (Snellius Exped., 1929, Rijksmus. Leiden). AUSTRALIA: WESTERN AUSTRALIA: Long Id., Dampier Archip. (Weaver and King, 1960, BPBM). NORTHERN TERRITORY: New Year Id. (V. Wells, ANSP). QUEENSLAND: Heron Id.; Fitzroy Id.; Lady Musgrave Id., east of Gladstone (all Aust. Mus.); Rudder Reef, off Port Douglas (Tony Marsh, ANSP). NEW GUINEA: reef flats, Soepiori Id., Schouten Ids.; Mios Woendi Atoll, Padaido Id. (both A. J. Osheiner, ANSP); Fak-Fak (Rijksmus. Leiden); Milne Bay (USNM); Finschhafen Bay (MCZ). BISMARCKS: Kaliai Reef, New Britain Id. (H. Coutournas, ANSP); Kaveing, New Ireland (West. Aust. Mus.). SOLOMONS: Buka, Bougainville Id. (MCZ); Treasury Id. (USNM); Pavuvu Id., Russell Group (USNM); Ususne, Malaita Id. (J. van der Riet, ANSP). MARIANAS: Guam (ANSP; USNM); Saipan (R. Sutcliffe, ANSP). PALAUS: Peleliu Id. (ANSP). CAROLINES: Ponape (A. J. Kohn, ANSP); Yap; Satawal Atoll (both USNM). MARSHALLS: Bikini; Eniwetok; Rongelap, Rongerik, Ailuk, Wotho Atolls (all USNM). GILBERTS: Apaiang (MCZ). NEW CALEDONIA: Voh (Paris Mus.); Koë Reef, Touho (G. and M. Kline, Orr, ANSP).

*Casmaria erinaceus subspecies*  
*kalosmodix* (Melvill, 1883)

(Pl. 14, fig. 17)

*Range*—Hawaiian Chain and Polynesia.

*Remarks*—It is with some hesitancy that I accept this form as a subspecies, for in some parts of its distribution it differs from the typical *erinaceus* in only one color character. Originally, this subspecies was established by Melvill on the basis of a very large specimen lacking the prickles on the outer lip. Although the habitat locality of the holotype is unknown, and despite the fact that Melvill claimed to have received a second specimen from Ceylon, I think it most probable that the original specimen came from the northwest Hawaiian Islands.

The absence of tiny spines or prickles is not at all diagnostic of this subspecies, for I have seen many specimens with them from Midway.

From Kauai to Hawaii and throughout the Polynesia Islands specimens bear 2 to 5 (usually 4) well-developed spines. Specimens from Midway to Necker are unusually large, sometimes reaching a length of four inches (103 mm.), and are progressively smaller towards the southeast. This phenomenon exists in other gastropods, such as *Terebra maculata* Linné. Curiously, 10 of 56 specimens examined from Midway have an extra varix one half whorl behind the last varix. Among the hundreds of specimens I have seen from the Philippines, I have seen only three with a second varix.

I find three overlap areas where both the typical race and *kalosmodix* occur, these being New Caledonia, Fiji and Malaita Island in the Solomons. Probably the New Hebrides are also within this boundary area. It is rather interesting that the subspecies *vibexmexicana* (Stearns) from Lower California is extremely close morphologically to Indian Ocean specimens, and lack the subsutural flames of chestnut which characterize the adjacent Polynesian race. It is possible that the Polynesian race is a very recent development, say, within the last 10,000 years, and that its characters are spreading to other populations westward towards Melanesia and the East Indies.

*Description*—The subspecies *kalosmodix* is best characterized by the dark-brown, oblong, irregularly-shaped blotches located just below the suture. The blotches are rarely as squarish as those in *C. ponderosa*, nor are they present on the base of the shell. The upper section of the outer lip (the varix) is usually without a brown stripe, a character more common in *ponderosa*. Rarely, in Oahu specimens, the blotches are continued over the body whorl in the form of "zebra-like" stripes. This subspecies may have a smooth or, rarely, a noded shoulder. The interior of the aperture may have a violet tint in fresh specimens, which with age turns brownish.

*Measurements* (mm.)—

length	width	no. whorls	
103.0	58.0	8	large; Midway; BPBM
78.0	41.8	7	large; Midway; MCZ
56.0	31.5	7	average; Tutuila Id., Samoa
35.4	20.5	7	small; Midway; ANSP
25.7	15.0	6	smallest; Midway; ANSP

*Synonymy*—

1857 *Cassis vibex* var., Küster, Systemat. Conchyl.-Cabinet, new series, vol. 3, pt. 1 b (395th part of 1892), p. 35, pl. 50, fig. 7 (no locality).

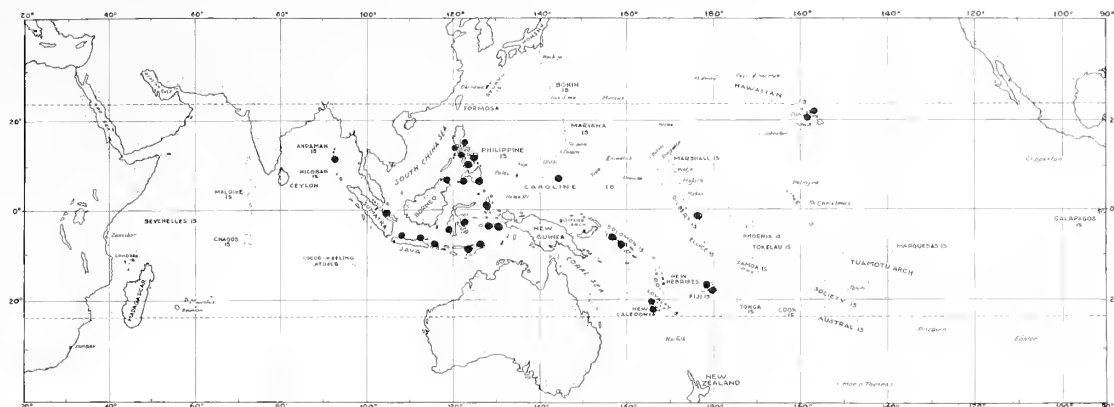


Plate 180. Distribution of a single character (zigzag stripes on the outer shell) over the range of two subspecies of *Casmaria erinaceus* (Linné).

1883 *Cassis kalosmodix* Melvill, Journal of Conchology, vol. 4, p. 43, pl. 1, fig. 1, (locality unknown); 1905, *ibid.*, vol. 11, p. 177 (Ceylon [error?])

1958 *Casmaria erinaceus* (Linnaeus) and var. *kalosmodix* (Melvill), Tinker, Pacific Sea Shells, Tuttle Co., ed. 2, p. 86, figs. top row center and lower right.

**Types**—The type of *Cassis kalosmodix* Melvill is in the Tomlin collection in the National Museum of Wales, United Kingdom. Since Melvill gave no locality in the original description we select Midway, Hawaiian Chain.

**Nomenclature**—There may be two earlier names for this subspecies, although there is no proof, and the probabilities are very slight. Link proposed the name *Phalium edentulum* in 1807, referring to a smooth form of *erinaceus* (Conchyl.-Cab., vol. 2, fig. 363; no locality) and commenting “our specimen equals the figure but the description talks about teeth.” I have relegated the name to the synonymy of *erinaceus* forma *vibex* Linné. In 1798, Röding applied the name *Cassis glabra* to Lister’s plate 1013, fig. 77. That figure might be construed as either of three shells (*ponderosa* forma *quadrata* (Link), *erinaceus* forma *vibex* (Linné), or possibly *kalosmodix* Melvill). I believe it wisest to sink it in the synonymy of *erinaceus*, and perhaps declare it a *nomen oblitum*.

**Records**—HAWAIIAN CHAIN: Ocean Id. (Kure); Midway; Laysan Id.; Lisianski Id. (all BPBM); Pearl and Hermes Reef (MCZ and USNM); Kauai Id. (MCZ); Niihau Id. (BPBM). OAHU ID.: off Waikiki; Paumotu; Mokapu (BPBM). MAUI ID.: Puunoa Pt., Lahaina (BPBM). LINE ISLANDS: Palmyra; Christmas (both BPBM). NEW CALEDONIA: Lifu Id. (Manchester Mus.); Voh (M. Defour, ANSP). SAMOA: Tutuila Id.; Upolu Id. (both ANSP); Savage Id., south of Samoa (Brit. Mus.); Ofu Id. (BPBM). TONGA: Tongatapu Id. (Saia Tuipulotu, ANSP, 1965). COOK IDS.: Li-



Plate 181. *Casmaria erinaceus* subspecies *vibexmexicana* (Stearns, 1894). Off Lobos Island, La Paz, Mexico. 70 mm. (courtesy of W. K. Emerson).

kopua Islet, Aitutaki (R. Robertson, 1952, ANSP); Mauke Id.; Rarotonga Id. (both H. J. Morgan collection). SOCIETY IDS.: Aitiue, Punoauia, Tahiti Id. (R. Robertson, ANSP); Bay Vairahi, Raiatea Id. (Wesley Heilman, ANSP); TUA MOTU IDS.: Raroia Id. (J. P. E. Morrison, USNM); Vahitahi Id. (D. Marshall, USNM); Gambier Id. (Seurat, Paris Mus.). [records from the Marianas need confirmation].

### *Casmaria erinaceus* subspecies *vibexmexicana* (Stearns, 1894)

(Pl. 181)

**Range**—Southern region of Lower California to Panama; Galapagos Islands.

**Remarks**—Although no living specimens of this subspecies have as yet been collected, the ten reliable locality records leave little doubt that *Casmaria erinaceus* exists in Eastern Pacific

waters. Curiously, these specimens closely resemble specimens from the Indian Ocean and the Southwest Pacific in nearly all respects, including the presence of minute, blackish, axial rows of “fly-speck” dots along former growth stoppages. Unlike the Polynesian subspecies, *kalosmodix* (Melvill), they have no brown, short, axial flames below the suture. This may suggest that the invasion from the central Pacific to the Eastern Pacific (or reverse direction) took place before the development of the Polynesian race. I can find no worthy differences between *vibex-mexicana* and *erinaceus erinaceus*, save that the former has a purplish interior to its aperture. Of possible significance, as Keen notes (1960), are “two diffused spots of yellow at the anterior end of the aperture, one on either side of the canal opening.” I am, for geographical and practical reasons, treating *vibexmexicana* as a subspecies until study of the soft parts can be made.

<i>Measurements</i> (mm.)—			
length	width	no. whorls	
70.0	42.0	6+	Lobos Id., near La Paz
41.5	26.0	6+	San Juanito Id., AMNH
34.9	21.5	5+	holotype, USNM

*Types*—The type locality is María Madre Id., Tres Marias Islands, Mexico. The holotype is in USNM 88831.

*Synonymy*—

1893 *Cassis* (*Casmaria*) *vibex* Linné, Stearns, Proc. U.S. Nat. Mus., vol. 16, no. 941, p. 348 (Tres Marias and La Paz, Lower California); 1958, Keen, Sea Shells of Tropical West America, Stanford, p. 340.  
1894 *Cassis* (*Casmaria*) *vibex-mexicana* Stearns, Proc. U.S. Nat. Mus., vol. 17, no. 996, p. 188; refers to his 1893 description (María Madre Islands, Tres Marias Ids., and La Paz, Lower Calif.); 1933, Lowe, Nautilus, vol. 46, p. 112; 1937, Hertlein, Proc. Amer. Philos. Soc., vol. 78, no. 2, p. 306; 1960, Keen, ed. 2, p. 340, fig. 314; 1963, Emerson and Old, Jr., Nautilus, vol. 76, no. 4, p. 143, pl. 10, figs. 1-3.

*Records*—EASTERN PACIFIC; MEXICO—Baja California: San Jose Id. (H. W. Lowe, 1932); Santa Catalina Island (W. K. Emerson, 1962); Buena Vista, Palmos Bay (Antonio Verdugo, 1961); Lobos Island, in 20 feet of water, near La Paz (Verona McKibbin); La Paz (L. Belding, 1892); Tres Marias Islands: María Madre Id. (W. K. Fisher, 1892); María Cleofas Id. (George Willett, 1938); San Juanito Id. (W. K. Emerson, 1961). [records from Emerson and Old, 1963]. COSTA RICA: Coronado (Jane Ruer, 1932, ANSP). PANAMA: Pearl Islands (F. H. Bradley, 1866, Yale Peabody Mus.). GALAPAGOS IDS.: Espumilla Beach, James Bay, San Salvador Id.; beach on Jervis Id. (both Mrs. Carmen Angermeyer, coll.).



**Casmaria ponderosa subspecies  
ponderosa (Gmelin, 1791)**

(Pl. 14, figs. 1-4; pls. 182-185)

**Range**—Red Sea and East Africa to eastern Polynesia.

**Remarks**—*Casmaria ponderosa* (Gmelin) usually differs from *erinaceus* (Linné) in having two rows of prominent square blotches, one just below the suture, the other on the base of the body whorl. Polynesian specimens of *erinaceus* have oblong blotches below the suture but none at the base of the shell. In *ponderosa*, there are one or two rows of prickles usually running the entire length of the outer lip. The spire is proportionately higher and the whorls more globose in *ponderosa*.

*Casmaria ponderosa* (Gmelin) is a very variable and widely distributed species found in shallow, sandy areas. In examining and geographically arranging over 200 lots of perhaps a thousand specimens, I have concluded that two additional subspecies should be recognized because of their isolation and several constant characters, namely *nipponensis* Abbott and *atlantica* Clench, 1944. However, I note the presence of certain single characters in certain areas which suggest incipient subspecies. I refer to these as forms since they may be rare or common in any given locality, and they may occur in combinations without uniform geographical distributions. Although some of these forms have received names in the past, I think it wise not to accept them even as subspecies.

*C. ponderosa* of the tropical Indo-Pacific may be heavy with strong plications on the shoulder

or be light-weight and with a smooth body whorl. Intergrades exist in many localities, although the heavy form appears to be more prevalent in the area of coral atolls and outer reefs. The smooth shells are the form *quadrata* (Link, 1807), which Reeve also named *torquata* in 1848. Sowerby illustrated it in 1842 in figure 411 of his "Conchological Manual".

The form *turgida* (Reeve, 1848) appears to be limited to the central Philippines. The shells are light-weight, thin, somewhat globose, smooth, with 8 to 12 prickles on the outer lip, and especially characterized by axial, wavy, zigzag brown bands or stripes. The square subsutural blotches are poorly defined, and are scarcely evident on the base. The shell is large, ranging from 42 to 55 mm. in length, (see pl. 184). This form should not be confused with the "zebra-striped" color phase of *erinaceus* which is commonest in the southwest Pacific area (see pl. 14, fig. 9). It is quite possible that the form *turgida* is a hybrid between *ponderosa* and *erinaceus*. Large, rotund, smooth specimens of *ponderosa* occasionally are present in the Red Sea, but they lack the zigzag brown bands. The "Challenger" specimen from the Admiralty Islands (Watson, 1886, p. 409) is a young, smooth *ponderosa* and not the form *turgida*.

The form *cernica* (Sowerby, 1888), originally described from Mauritius, has appeared in the Red Sea. I have hesitated to recognize it as a subspecies. Typical forms of *ponderosa* also occur in Mauritius. Curiously, the Caribbean subspecies, *atlantica* Clench, is almost indistinguishable from this form. In both, the shells are light-weight, with 4 to 7 prickles on the lower half of the outer lip, and with 3 spiral rows of light-fawn, squarish spots on the middle of the body whorl between the usual subsutural and

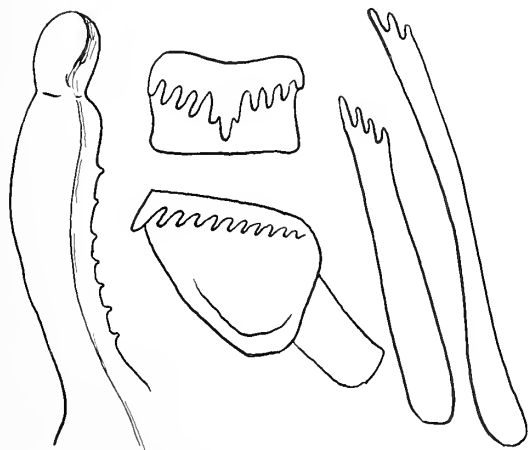


Plate 182. *Casmaria ponderosa* (Gmelin). Penis and radulae from knobbed form from Fiji Islands.



Plate 183. *Casmaria ponderosa* (Gmelin, 1791) forma *quadrata* (Link, 1807). Holotype of *Cassis torquata* Reeve, 1848. 31 mm. in length. British Museum (Natural History).

basal color spots. Examples of *cernica* are found on our plate 14, fig. 18 and in Kiener, 1835, *Coquilles Vivantes*, Paris, vol. 8, pl. 11, figs. 21a. The shape of the small shell is more like that of the elongate *erinaceus*. I believe this form may be the remnant of an earlier stock which was widespread throughout the Tethys Sea, perhaps during the early Miocene. It has changed little since then in the Caribbean, but in the Indo-Pacific has been gradually swamped out by the centrally located *ponderosa* and *quadrata* forms. A *cernica*-like subspecies is dominant in the cooler Japanese waters, and is discussed below under the remarks of *nipponensis* Abbott.

The coral atoll form, *nodulosa* (Gmelin, 1791), is common in Micronesia and sporadically present in Melanesia, Indonesia and the Maldives Islands. This form is reminiscent of the Micronesian race, or ecologic form, *Strombus variabilis athenius* Duclos, 1844 (see Indo-Pacific Mollusca, vol. 1, no. 2, p. 104 [p. 09-942]). In both, the shell is heavy, stunted, lighter in color and with a more extended spire. In this *Casmaria*, the shells are strongly noduled at the shoulder, the varix is very thick, the peristome is thickened, the spire is usually quite high, and the number and density of the color spots are greatly reduced. In some, the shell is almost all-white, except for the brown, varical blotches. This form is dominant in the Marshall, Caroline and Gilbert Islands, but occasionally occurs in northern New Guinea, the Philippines, Indonesia, Palau Islands and the Maldives in the Indian Ocean. I suspect this form, and that of the *Strombus*, is due to ecologic conditions, such as the absence of rich, high island muds.

**Description**—Adult shell 20 to 55 mm. ( $\frac{3}{4}$  to 2 inches) in length, solid, glossy, ovate-elongate, with a smoothish, rounded columella, with a moderately-developed, black-striped varix, with one or two rows of denticles on the outer lip, and with a subsutural and basal spiral row of squarish chestnut splotches on the last whorl. Whorls 8. Nuclear whorls 3, the first very small and stained brown, the remaining two rapidly increasing in size, glossy, white and smooth. The whorl dips slightly and forms a break in the growth just before the postnuclear whorls begin. Body whorl well-rounded and with a smooth or axially noduled shoulder. Color of shell white, tan, bluish white or cream with a spiral row of about 7 to 9 chestnut squarish spots just below the suture and on the base of the body whorl. Between these two rows may be

3 weak spiral tan bands or 3 rows of weak, squarish spots. In smooth, light-weight specimens, the varix bears 5 to 12 small, sharp denticles, but in noduled, heavy specimens there is a second row of more numerous, smaller denticles slightly within the aperture. A former varix is very rarely present. The top or posterior end of the varix is without a chestnut stripe, but below are 7 to 10 variously-sized chestnut to blackish bands. Columella shield solid, white, rounded, smoothish or with numerous spiral wrinkles. Interior of aperture white to light-brown. Umbilicus sealed over; false umbilicus absent. Siphonal canal short and tipped with a chestnut splotch. Operculum one-fourth the length of the aperture; fan-shaped; narrow (12 x 4.5 mm.), and translucent-yellow.

#### Measurements (mm.)—

length	width	no. whorls	
51.5	30.0	8	form <i>turgida</i> Reeve; Cebu Id.
42.2	26.8	8	average; smooth; Cebu Id.
41.0	25.5	8	average; noduled; Bohol Id.
37.1	23.7	8	holotype of <i>torquata</i> Reeve
20.0	12.5	7	smallest; Mozambique

#### Synonymy—

- 1791 *Buccinum ponderosum* Gmelin, *Systema naturae*, ed. 13, p. 3477, no. 28 (no locality); refers to Lister, pl. 1016, fig. 74 [nodulose form].  
 1791 *Buccinum nodulosum* Gmelin, loc. cit., p. 3479, no. 38 (no locality); refers to Schroeter's Einl. in Conch., vol. 1, p. 383, pl. 2, fig. 9. Non Gmelin, loc. cit., p. 3496 [coral atoll form].  
 1792 *Cassidea erinaceus* Linné, Bruguière, *Encyclopédie Méthod. (Vers)*, vol. 1, p. 418.  
 1807 *Phalium quadratum* Link, *Beschreibung der Natur-Samml.*, Rostok, pt. 2, p. 113; refers to Conchyl.-Cab., vol. 2, figs. 385, 386 [smooth form].



Plate 184. *Casmaria ponderosa* (Gmelin, 1791), forma *turgida* (Reeve, 1848). Laminusa Id., near Siasi, Sulu Archipelago, Philippines. Both 67 mm. Western Australian Mus. no. 863-66.

- 1817 *Buccinum biarmatum* Dillwyn, Descriptive Catal. Shells, London, vol. 2, p. 599, no. 32 (no locality). New name for *Buccinum nodulosum* Gmelin, 1791, p. 3479, non Gmelin, p. 3496.
- 1817 *Buccinum pantherina* "Solander" Dillwyn, loc. cit., p. 599 (indirectly refers to Conchyl.-Cab., vol. 2, figs. 383-386).
- 1828 *Cassis nodulosa* Gmelin, Menke, Synopsis method. Molluscorum, Pymont, p. 36.
- 1828 *Cassis tenuilabris* Menke, loc. cit., p. 36 and 87 (ad Javum); 1830, ed. 2, p. 145.
- 1848 *Cassis torquata* Reeve, Conchologica Icon., vol. 5, *Cassis* sp. and fig. 1 (New Holland).
- 1848 *Cassis turgida* Reeve, loc. cit., vol. 5, *Cassis* sp. and fig. 25 (Boljoon, Island of Zebu, Philippines); 1859, Chenu, Manuel de Conch., vol. 1, p. 207, fig. 1131.
- 1857 *Cassis torquata* Reeve, Küster, Systemat. Conchyl.-Cabinet, new series, vol. 3, pt. 1 b, p. 15, pl. 39, figs. 3-6, pl. 48, figs. 5, 6, pl. 49, figs. 5, 6.
- 1888 *Casmeria torquata* Reeve, Jousseume, Mém. Soc. Zool. France, vol. 1, p. 190.
- 1888 *Cassis cernica* Sowerby, Proceed. Zool. Soc. London, 1888, p. 211, pl. 11, fig. 19 (Mauritius).
- 1910 *Cassidea nodulosa* Gmelin var. *torquata* Reeve, Hedley, Report Australian Assoc. Adv. Sci., Brisbane, 1909, p. 361 (Queensland).
- 1927 *Casmaria ponderosa* (Gmelin), Iredale, Records Australian Mus., vol. 15, p. 338; 1961, Habe, Coloured Illus. Shells of Japan, vol. 2, pl. 21, fig. 3.

**Nomenclature**—During the 18th and 19th centuries, this species was erroneously referred to as Linné's *erinaceus* by various authors and it also received a number of synonyms. Iredale in 1927 was the first to present a good account of the synonymy and to establish the use of Gmelin's name of *ponderosa*. His concept of the species, however, was largely based on Australian specimens. I add the names *turgida* Reeve, 1848, and *cernica* Sowerby, 1888, to the synonymy. Dillwyn and Iredale have pointed out that Gmelin described two *Buccinum nodulosum*. The one on page 3479 is the coral atoll

form of our *Casmaria ponderosa* (Gmelin), and the one on page 3496 (a homonym) is "*Murex morbosus* Dillwyn, 1817", a *Thais* (?*rustica* Lamarck, 1822) from the West Indies. In all likelihood, *Cassis tenuilabris* Menke, 1828, from Java is the typical form of *ponderosa*.

**Types**—Gmelin evidently had no specimens. His *ponderosa* is based upon Lister's plate 1016, fig. 74, which is a drawing of a shell now probably in Lister's collection in the Oxford University Museum. Reeve's holotype of *torquata* and syntypes of *turgida* are in the British Museum (Natural History). Sowerby's type of *cernica* (1888) seems not to be identifiable. Sowerby and Fulton probably received several dozen specimens which were sold to several people, including Tryon (ANSP no. 107802) and Melville (now in the National Museum of Wales, Cardiff).

**Records**—(also see accompanying map. Solid dots: specimens examined). NATAL: Durban (E. A. Smith, 1903, p. 379). MOZAMBIQUE: Mozambique City (Kurt Grosch, ANSP); 10 meters, Nacala (F. B. Steiner, ANSP); Porto Amelia (F. M. Borges, ANSP). ZANZIBAR: Chumbe Id.; ½ mi. south of Nyange Id. (both A. J. Ostheimer, 3rd, ANSP). MADAGASCAR: Nossi-bé (A. Chavane, ANSP); Ankifi, near Nossi Komba; Nossi Iranja; (both ANSP Exped., 1961); Ile Ste. Marie (R. W. Foster MCZ). MAURITIUS: Pointe aux Sables (ANSP). CHAGOS: (form *cernica*; Poisson, H., 1953, p. 66). SEYCHELLES: Cerf Id. (A. J. Kohn, Yale Peabody Mus.). MALDIVES: Gan Id., Addu Atoll (A. J. Kohn, Yale Peabody Mus.); Mulaka Atoll (Peggy Carpenter, ANSP). CEYLON: Trincomali (Brit. Mus.). ANDAMANS: Port Blair (Brit. Mus.). RYUKYUS: (ANSP; MCZ; USNM). FORMOSA: Taihoku-syn; Karenko; Garanbi; Hoko (all Kuroda, 1941, p. 104). PHILIPPINES: 6 fms., east end of Corregidor Id.; and near Cubat, Sorsogon Prov. (both Luzon Id., duPont-Academy Exped., 1958). Also records from Mindoro, Balabac, Cuyo, Bohol, Camiguin, Cebu, Catanduanes, Samar, Jolo, Sanga Sanga Ids. (all ANSP); Lubang, Mindanao and Negros

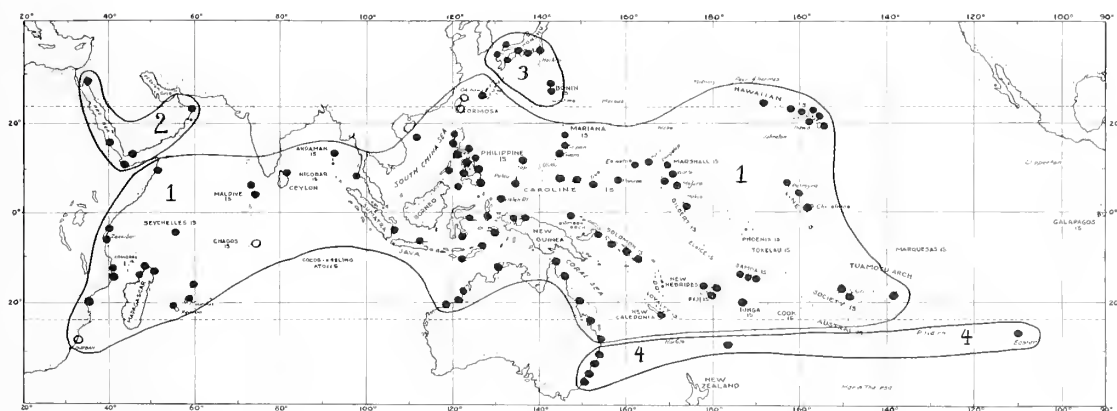


Plate 185. Geographical distribution of *Casmaria ponderosa* (Gmelin) and its subspecies. 1, typical *ponderosa* (Gmelin); 2, subspecies *unicolor* (Dautzenberg); 3, subspecies *nip-*

*ponensis* Abbott; 4, subspecies *perryi* (Iredale). A fifth subspecies, *atlantica* Clench, from the Caribbean is not shown on this map.



Ids. (MCZ); Masbate Id.; Davao, Mindanao (both USNM). INDONESIA: Tengah Id., off Boeroe Id. and Mandidi Id., Moluccas; N. Loloda Id., west of Halmahera Id., and Batjan Id., Moluccas (all D. Fairchild, MCZ); Banda Id. (Natuurhist. Mus. Enschede); Poeloe Sebangka, Lingga Arch.; Wetar Id., north of Timor; Amboina; Timor (all Rijksmus. Leiden). NEW GUINEA: Rouw Id., Aori Ids., Geelvink Bay (A. J. Ostheimer, 3rd, ANSP); Djamma Id., (MCZ). CHINA: Paracel Ids. (Berlin Mus.). AUSTRALIA: WESTERN AUSTRALIA: Trevenard Id., and Long Id., and 8 fms. off Port Walcott (all M. E. King, BPBM). NORTHERN TERRITORY: 20 fms., 100 mi. N.W. of Darwin (Vernon Wells, ANSP). QUEENSLAND: St. Crispens Reef (T. Nielsen, ANSP); near Thursday Id. (V. Wells, ANSP); Heron Id. (ANSP); off Moreton Bay; Frazer Id.; off Caloundra; off Southport; off Tin Can Bay, Wide Bay (all Joy Kerslake, ANSP); Lizard Id., 150 mi. north of Port Douglas (Tony Marsh, ANSP). NEW SOUTH WALES: Trial Bay; Shelly Beach, near Yamiba (both J. Kerslake, ANSP). SOLOMONS: Roviana Lagoon, South New Georgia Id. (MCZ); Ususue, Malaita Id. (J. van der Riet, ANSP); Buin, Bougainville Id. (A. H. Joyce, ANSP). NEW CALEDONIA: 10 fms., sand, off Noumea: 1 fm., 4 mi. W. by N. of Gatope Id., Voh (both G. and M. Kline, ANSP); Koumac (Maurice Frouin, ANSP). MARIANAS: Piti; Apra Harbor, Guam (A. J. Ostheimer, 3rd, ANSP and USNM); Agat, Guam Id. (USNM). PALAU IDS.: reef west of Malakal Harbor, Koror Id. (A. J.

Ostheimer, 3rd, ANSP); 2-5 fms., 1 mi. east of Round Rock, Helen Reef (V. Orr, ANSP). CAROLINES: Yap Id; Faraulep Atoll; Lukunor Atoll (all USNM); Ponape (W. H. Pease, MCZ); Nukunoro Atoll (V. Wertley, ANSP); Mortlock Id.; Kapingamarangi (BPBM). MARSHALS: Bikini, Rongelap, Majuro, Eniwetok, Kwajalein, Taka, Ujae, Lae, Ailuk, Ujelang and Wotho Atolls (all USNM). FIJI: Akuilan Id.; Namotu Id.; 5-20 fms. off Namotu Id., N.W. Viti Levu Id. (all A. Jennings, ANSP); Suva (H. S. Ladd, USNM). GILBERTS: Apaiang Id. (A. Garrett, MCZ). HAWAIIAN CHAIN: 64 and 66 fms., off south end Molokai Id. ("Albatross" Sta. 3845, USNM); off Waikiki, Oahu Id., 35-50 fms. (D. Thaanum, USNM); off Launiupoko, Main Id., 4-12 fms. (D. Thaanum, USNM); Anau Channel, 2128 fms. ("Albatross" Sta. 3871, USNM); 15 fms., in sand, Keehe, Oahu Id. (C. S. Weaver, ANSP); Lisianski Id.; Hawaii Id.; Haena, Kanai Id. (all BPBM). LINE IDS.: Fanning; Christmas (both BPBM). SAMOA: Fagaitua Bay, Tutuila Id. (R. T. Abbott, MCZ); Ofu Id. (Ted Dranga, MCZ). TONGA: Nukualofa (BPBM). SOCIETY IDS.: Atiue, Tahiti (R. Robertson, ANSP); Borabora Id. (D. C. Voy, ANSP). TUAMOTUS: Raroia (Dautzenberg coll'n., Bruxelles).

*Fossil Records*—Pleistocene; 550 ft. alt., Kauain Stream, Lanai Id. (Harold Stearns, USNM). Pleistocene [?]: Rynkyu Limestone, Kikau-Zima (Nomura and Zinbo, 1934, 139) which I have not seen.

***Casmaria ponderosa subspecies unicolor* (Dautzenberg, 1926)**

(Pl. 14, fig. 5; pl. 186)

*Range*—Red Sea and the Gulf of Aden to the Gulf of Oman, Arabia.

*Remarks*—Most specimens from the above range characteristically have a very bulbous, swollen last whorl. This swelling is high on the whorl, so that the shell has a somewhat roundly tabulate appearance. Fresh specimens may have a peculiar greenish lead background with a coarse cobwebbing of bluish brown, or they may be cream-white or yellowish brown. In some specimens the subsutural and basal row of spots may be weak, small or nearly absent, a fact which led Dautzenberg to propose the name *unicolor*. The characters of this subspecies have not become uniformly established in this area. Specimens may be extremely small (23 mm.) or very large (65 mm.) and, in some, the globosity may be as little developed as in typical southwest Pacific specimens.

*Measurements (mm.)—*

length	width	no. whorls	
72.0	48.1	8	largest; Red Sea
65.5	46.0	8	large; Eilat, Red Sea
58.0	35.0	7+	Jobal Straits, Red Sea
57.6	38.5	6+	Muscat, Oman
42.0	25.2	7	Djibouti, French Somalia
22.5	16.5	7	smallest; Eilat, Red Sea

*Types*—The type locality is "Red Sea". I was unable to locate the holotype either in Paris or in the Dautzenberg collection in Bruxelles.

*Synonymy*—

- 1827 *Cassis vibex* L., Audouin, Descr. Egypte, vol. 22, Expl. planches Savigny, p. 186.  
 1869 *Cassis quadrata* Link, Issel, Malocologia del Mar Rosso, Pisa, pt. 2, p. 121 (Mar Rosso); pt. 4, p. 349.  
 1926 *Cassis (Casmaria) turgida* Reeve, var. *unicolor* Dautzenberg, Mémoires Inst. d'Egypte, vol. 11, p. 88, pl. 10 (6), figs. 6 (Red Sea).  
 1935 *Phalium turgidum* (Reeve) var. *unicolor* Dautz., Bayer, Zoolog. Mededeelingen, Leiden, vol. 18, p. 114.

*Records*—RED SEA: Eilat, Gulf of Aqaba (H. Hadar, ANSP); Geb Zet (Lepsius, Berlin Mus.); Jobal Straits (Sozon Vatakotis, ANSP). FRENCH SOMALIA: Plage d'Arta, 50 kms. west of Djibouti (N. Lavergne, ANSP). ADEN: (Brit. Mus.). ARABIA: Muscat, Oman (D. T. Bosch, ANSP).



Plate 186. *Casmaria ponderosa* subspecies *unicolor* (Dautzenberg, 1926). Top two shells: 30 and 22.5 mm. in length, from Eilat, Gulf of Aqaba. Bottom shell: 51.3 mm. in length, from 50 kms. west of Djibouti, French Somalia.

*Casmaria ponderosa subspecies nipponensis* new subspecies Abbott

(Pl. 14, figs. 13, 14)

*Range*—Known only from Japan and the Bonin Islands.

*Remarks*—This is a very distinctive northern subspecies of Japanese cool waters which is characterized by its dull, brownish tan color, by its tan nuclear whorls and by the presence of 4 to 7 small prickles on the outer lip. These are located on the lower middle section and not at the base of the outer lip. The upper fifth of the last varix is without a brown spot. Below the suture are blurred darker-brown blotches, a feature present in the similar *C. ponderosa perryi* (Iredale) from southeast Australia, the Kermadecs, and Easter Island, and in the Polynesian *C. erinaceus kalosmodix* (Melvill). This new subspecies has been identified in the past by Japanese workers as *cernica* Sowerby, which, however, is a dwarf, light-colored form of *ponderosa* from Mauritius. *C. ponderosa perryi* (Iredale) lacks the prickles on the outer lip and has white nuclear whorls. One specimen of *nipponensis* (USNM 205464) from 103 fathoms in the Kagoshima Gulf, Japan, is a grayish tan uniform color.

A brightly-colored specimen of *nipponensis* was purchased in Okinawa by Mrs. A. Anita Scott, but I have seen no other specimens from the Ryukyu Islands.

*Description*—Shell 33 to 53 mm. (about 1-1/4 to 2-1/4 inches) in length, ovate to elongate-ovate, dull to somewhat shining, moderately heavy, and colored in dark tan, cream and darker-brown blotches. Nuclear whorls 4, smooth and light-tan. Postnuclear whorls smooth, except for occasional microscopic growth lines, and moderately rounded. Suture smooth, minutely indented. Color of whorls in apex tan or with a purplish tan background, and with irregular blotches of light-chestnut brown just below the suture. Body whorl with these subsutural blotches and with 4 or 5 weak, spiral bands of indistinct tan, squarish blotches. Varix at outer lip moderately to heavily developed and bearing 5 to 10 brown streaks. Outer lip with 4 to 7 tiny, sharp denticles, but none at the base. Umbilicus minutely impressed. Parietal shield absent. Columella tan-cream and with 4 to 7 weak plicae, the lowest, however, being very strong and at the base of the columella. Interior of aperture cream to

light-brown. Edge of siphonal fasciole stained light-brown. A former varix may be present one half whorl behind the last varix. Spire variable in height, from 1/3 to 3/5 the entire length of the shell. Operculum and soft parts unknown.

*Measurements*—

length	width	spire	no. whorls	
58.0	33.0	22.5	7.5	Figured holotype, ANSP
53.1	27.2	20.5	6+	Kii, Japan, ANSP 241636
42.7	24.1	14.5	7.0	Tanabe, Japan, MCZ 233233
39.9	22.8	12.4	7.0	Sagami, Japan, ANSP 227579
33.4	20.5	9.8	6+	Sagami, Japan, ANSP 227579

*Types and Records*—The type locality is Tanabe, Wakayama Prefecture, south central coast

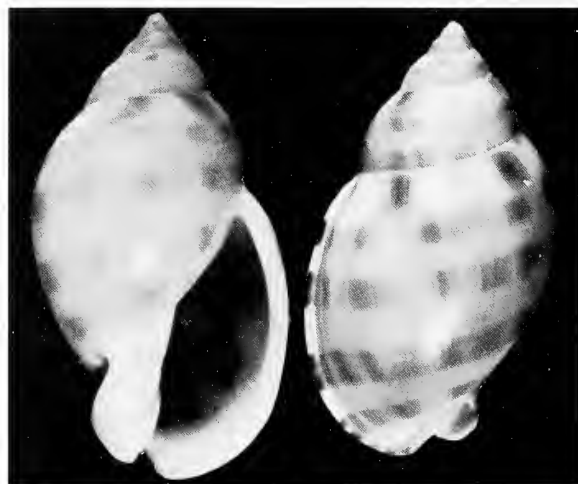


Plate 187. *Casmaria ponderosa* subspecies *perryi* (Iredale, 1912). Off Oruawharu, Great Barrier Island, North Island, New Zealand. 30.7 mm. in length. (photographs courtesy of A. W. B. Powell).



***Casmaria ponderosa subspecies  
perryi* (Iredale, 1912)**

(Pl. 187)

**Range**—Southeast Australia, New Zealand, Kermadec Islands and Easter Island.

**Remarks and Description**—This subspecies is the southern counterpart to the northern subspecies *nipponensis* Abbott from Japan. Both have a dull taffy-brown or tan cast, with moderately strong and elongate brown blotches just below the suture and with 3 or 4 wide, light-brown, indistinct, spiral bands on the body whorl which bear irregular squarish, brown blotches. Characteristic of the *ponderosa* group is the unspotted, upper (or posterior) end of the varix. *C. ponderosa perryi* Iredale differs from *nipponensis* in having no denticles along the lower third of the outer lip, in having a weak varix, and in having cream-colored instead of dark-tan to light pinkish tan nuclear whorls. Both subspecies exhibit variations in the relative height of the spire, some being quite drawn out. The Australian subspecies was described from the Kermadec Islands, northeast of New Zealand, by Iredale who mentions that some few specimens may have a former varix on the last half of the body whorl, a feature seen in some Japanese specimens. I find no significant differences in the slightly plicated to smooth columellae of these two subspecies. The distribution of a cool water species or subspecies from New South Wales, to the Kermadecs and Easter Island is normal for some other groups of mollusks.

of Honshu Island, Japan. The holotype is in the Academy of Natural Sciences of Philadelphia, no. 313258. Paratypes are as follows: KYUSHU ID.: Kagoshima (A. R. Cahn, coll'n., ANSP 241668). HONSHU ID.: Kii, Wakayama Pref. (A. R. Cahn, ANSP 241646; 241636); Awa, Chiba Pref. (A. R. Cahn, ANSP 241141); Chiba Pref. (A. R. Cahn, ANSP 254723); Sagami Bay (B. R. Bales coll'n., ANSP 227579; Nat. Sci. Mus. Tokyo); Tanabe, Wakayama Pref. (MCZ 233233); 103 fms., Albatross Station 4935, Kagoshima Gulf (USNM 205464).

**Measurements (mm.)—**

length	width	no. whorls	
52.5	27.0	9	Queensland, Australia
43	24	—	type, fide Iredale, 1912
41.7	24.5	7+	Queensland, Australia
30.7	17.0	—	Gt. Barrier Id., N.Z., fide Powell, 1967

**Synonymy—**

- 1911 *Cassidea cernica* Sowerby, Iredale, Proc. Mal. Soc. London, vol. 9, p. 73 (Kermadecs).  
1912 *Cassidea perryi* Iredale, Proc. Mal. Soc. London, vol. 10, p. 227, pl. 9, fig. 17 (Sunday Is., Kermadec Islands).  
1967 *Casmaria perryi* (Iredale), Powell, Records Auck. Inst. Mus., vol. 6, no. 3, p. 186, pl. 36.

**Types**—The type locality is Sunday Island, Kermadec Islands, northeast of New Zealand. The holotype was deposited by Iredale in the Canterbury Museum, New Zealand.

**Records**—AUSTRALIA: Tuncurry Beach, New South Wales (Thornley, 1954, Proc. Royal Zool. Soc. N.S.W., for 1952-53, p. 33); 40 fms., off Caloundra, southern Queensland (T. A. Garrard, coll'n.); Point Cartwright, Queensland (Nat. Mus. Vict. F23207). NEW ZEALAND: on rocks just below low tide, Oruawharu, Great Barrier Island, North Island (Mrs. G. Mitchener, leg. 1965). KERMADEC IDS.: Sunday Island (Iredale, 1912, p. 227). EASTER ISLAND: (USNM).

***Casmaria ponderosa subspecies  
atlantica* Clench, 1944**

(Pl. 14, figs. 15, 16)

**Range**—Lower Florida Keys, the Bahamas and Caribbean.

**Remarks**—This rare Caribbean subspecies is scarcely differentiated from certain specimens of *C. ponderosa* form *cernica* Sowerby, 1888, from the Indian Ocean. The shell of *atlantica* is slightly lighter in weight and the spots are more numerous in the four spiral series on the middle of the body whorl. I have never seen noduled specimens. This subspecies was treated in full by Clench in 1944 when he described it as a species and likened it to *Casmaria vibex* Linné (= *erinaceus* Linné, smooth form), rather than to the *ponderosa* group.

Young smooth forms of *Phalium granulatum* resemble this species, but *atlantica* is narrower, has a minute brown line on the suture of the first whorl, lacks reticulated sculpturing on the early whorls and has 5 to 9 minute prickles on the lower half of the outer lip.

**Synonymy—**

- 1935 *Phalium erinaceum* var. *vibex* Linné, Bayer, Zoologische Mededeel., vol. 18, p. 112.  
1944 *Casmaria atlantica* Clench, Johnsonia, vol. 1, no. 16, p. 3 (Puerto Sosua, Hispaniola).

**Records**—FLORIDA: 190 feet depth, off Destin, Florida (Frank Warder, coll'n.); 4-5 miles N.N.E. of The Elbow, Key Largo, in 50-83 fathoms (L. A. Burry, MCZ). BAHAMAS: Bimini (Corinne Edwards, 1967); Abrahams Bay, Mariguana Id.; Matthewtown, Great Inagua Id. (both MCZ); New Providence Id. (ANSP). CUBA: outer beaches, Guantanamo Naval Base (Kathy Carson and Pauli La Plante, 1967, ANSP). HISPANIOLA: Monte Cristi; Puerto Sosua (type locality) (both MCZ). VENEZUELA: near Caracas (Ch. Bayer, 1935, p. 112).

*Published by*  
THE DEPARTMENT OF MOLLUSKS  
*Academy of Natural Sciences of Philadelphia*  
19th and the Parkway  
Philadelphia, Pennsylvania 19103

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# INDO-PACIFIC MOLLUSCA

PUBLISHED BY  
THE DEPARTMENT OF MOLLUSKS  
Delaware Museum of  
Natural History  
Greenville, Delaware 19807  
U.S.A.

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*Publication commenced*  
*March 31, 1959*  
*Volume 2 commenced*  
*August 30, 1968*

*Monographs of the Marine Mollusks of  
the World with Emphasis on those of the  
Tropical Western Pacific and Indian Oceans*

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<i>uttleyi</i> Allan, 374	23-482		
		<i>xeniae</i> Boettger, 382	23-506
<i>variabilis</i> Schepman, 281	23-293		
<i>venusta</i> Powell, 401	23-587	<i>yokoyamai</i> Otuka, 383	23-519
<i>vepallida</i> von Martens, 360	23-446	<i>yokoyamai</i> Oyama, 277	23-289
<i>verrilli</i> Dall, 335	23-397		
<i>verrucosa</i> Suter, 260	23-268		
<i>Vexitomina</i> Powell, 323	23-369	<i>Zemacies</i> Finlay, 353	23-431

## THE FAMILY TURRIDAE IN THE INDO-PACIFIC

## Part 2. The subfamily Turriculinae

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The members of this subfamily are shells of moderate to large size, mostly of narrowly fusiform shape, with a tall spire and a long flexed to straight anterior canal. Typically the sinus is deep, rounded to U-shaped, and always situated upon the shoulder slope, often occupying most of it.

The radula has a formula of either  $1 + 0 + 0 + 0 + 1$  or  $1 + 0 + 1 + 0 + 1$ , the central tooth being absent, vestigial or large and with a broad rectangular base. The marginals are either simple wishbone-shaped, or with one of the basal limbs severed. Laterals have not been observed in the Turriculinae, but their place is in many cases occupied by a great enlargement of the basal plate of the central tooth.

Typically, the operculum is clavatulid, that is, with a mediolateral nucleus, incurved below in the case of *Marshallena*, or leaf-shaped with a terminal nucleus as in *Comitas*.

The subfamily has a wide distribution, both Recent and fossil, and was already well-represented as early as the upper Cretaceous. While this monograph deals in more detail with Indo-Pacific species, a number of extra-limited genera have been briefly outlined in order to present a complete treatment of the higher classification of the subfamily Turriculinae. Among these 20 or more groups are such genera as *Acamptogenotia* Rovereto, *Megasurcula* Casey, *Fusiturricula* Woodring, *Knefastia* Dall and *Pseudomelatoma* Dall. These are diagnosed briefly here on pages 23-489 to 23-568. Some of them may subsequently be found either living or fossil in the Indo-Pacific as more collecting takes place, particularly in deep water. Some deep-water occurrences qualify geographically as tropical Indo-Pacific, but they actually inhabit the cool waters of the ocean basins. Similarly, the genus *Austrotoma* of the Austro-Neozelanic Tertiary and the three genera, *Belatomina*, *Belophos* and *Liratomina* of the middle and late Tertiary of Tasmania and southern Australia are included in this treatise since they represent a subtropical

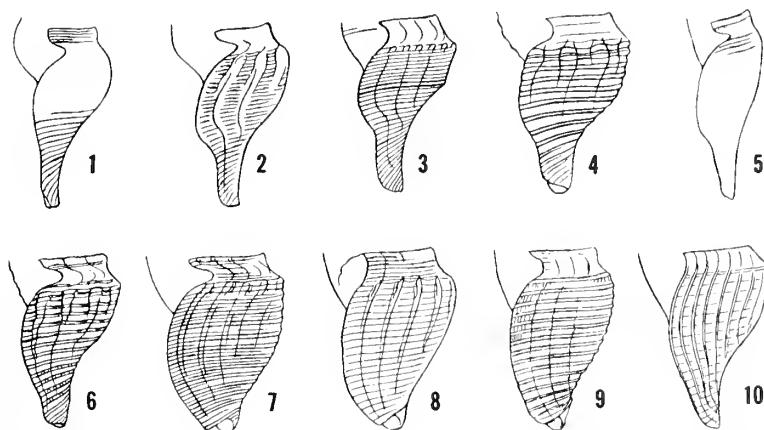


Plate 188. Labial profiles in the subfamily Turriculinae. Fig. 1, *Turricula tornata* (Dillwyn). Fig. 2, *Comitas fusiformis* (Hutton). Fig. 3, *Paracomitas castlecliffensis* (Marshall & Murdoch). Fig. 4, *Anticomitas viveus* Powell. Fig. 5,

*Zemacies elatior* Finlay. Fig. 6, *Knefastia olivacea* (Sowerby). Fig. 7, *Vexitomina metcalfei* (Angas). Fig. 8, *Belophos woodsi* (Tate). Fig. 9, *Austrotoma minor* (Finlay). Fig. 10, *Marshallena neozelanica* (Suter).



element in this area at a time when the Indo-Pacific fauna occupied a much wider zone than obtains at present.

The clavatulids, which probably originated from turriculinid stock in the Oligocene, have retained the clavatulid operculum exclusively, but most of the turriculinid genera have developed the leaf-shaped operculum with the terminal nucleus. However, we still do not know how widely separated morphologically are the representatives of these two opercular types.

Since the central tooth has proved to be an unstable element in *Gemmula* and in other subfamilies, the presence of the enlarged broad-based central in the "Cochlespirinae" has lost its significance. That subfamily is now merged into the Turriculinae.

Very little is known of the anatomy of turrids in general, and what work has been published refers more specifically to the Mangeliinae and Daphnellinae. Nevertheless this information is likely to prove more or less applicable to the other subfamilies of the Turridae, and is hence worth quoting below, in connection with the subfamily at present under review.

### Anatomy

#### Proboscis—

Smith (1967a) described in detail the proboscis and oesophagus of some British turrids of the subfamilies Mangeliinae and Daphnellinae. Two new types of proboscides, presumably peculiar to the toxoglossa, and to the turrids in particular, were named.

For one of these proboscid types the term "intraembolic" was proposed. This type of

proboscis is found in "*Lora*", *Mangelia*, *Haedropleura*, and possibly in other genera of turrids, as well as in the Conidae and the Terebridae. It is characterized by the following feature: "The rhynchodaeum is not an integral part of the proboscis but forms merely a sac within which the proboscis extends and retracts."

For the other type of proboscis the term "polyembolic" was proposed. This second type of proboscis is found in *Philbertia leufroyi boothi*, *P. purpurea* and in *Cenodagreutes*. The latter genus was proposed by Smith (1967c) for two species of British turrids, scarcely distinguishable from *Philbertia leufroyi boothi* upon shell characters, but entirely without radula, poison gland and salivary glands. This second type of proboscis is characterized by the following features: "(1) the introvert is formed by the extension of the walls of the rhynchodaeum and retracts by the infolding of the walls of the rhynchodaeum; (2) a pseudo-rhynchostome forms the opening into the rhynchodaeum when the proboscis has reached the contracted state; (3) the buccal cavity and oesophagus remain at the base of the rhynchodaeum and do not extend with the proboscis; (4) the retractor muscles are attached all along the walls of the rhynchodaeum."

#### Radula—

Smith (1967a) also advanced the following interpretation of the feeding process in the turrids: "As the mollusc begins to hunt for food a tooth is transferred from the radular sac to its functional position at the top of the proboscis. The proboscis is extended and begins to search

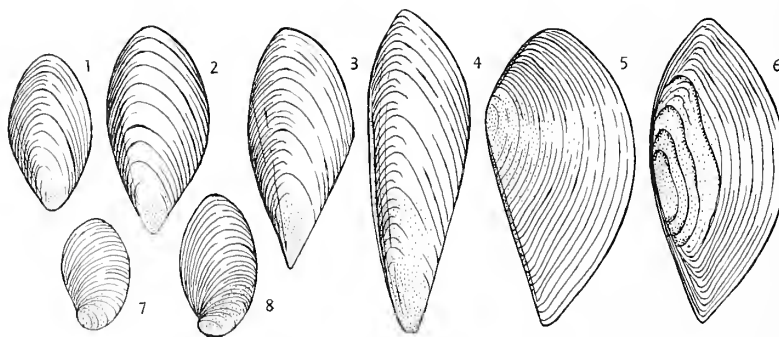


Plate 189. Opercula of some Turriculinae. Fig. 1, *Comitas onokeana vivens* Dell, Chatham Rise, 260 fathoms, New Zealand. Fig. 2, *Comitas stolidus* (Hinds), False Bay, 30 fathoms, South Africa. Fig. 3, *Comitas kaderlyi* (Lischke), Tosa, 70 fathoms, Japan. Fig. 4, *Comitas galathea* Powell new species, off Aru Islands, 352 metres. Fig. 5, *Turricula javana*

(Linnaeus), Madras, India. Fig. 6, *Turricula tornata fulminata* (Kiener), Muscat, Gulf of Oman. Fig. 7, *Marshallena nereis* (E. A. Smith), Gulf of Aden, 1061 metres. Fig. 8, *Marshallena nierstraszi* (Schepman), Buton Strait, 559 fathoms, Celebes.

the soft substrate for small polychaetes in the manner described for some cones by Kohn (1959). When the prey is located, the proboscis lumen is filled with poison by contraction of the muscular bulb of the poison gland, the tooth is stabbed into the prey and the poison flows into the wound. The proboscis is then retracted and the tooth either withdrawn or detached and left behind in the wound. The latter seems the more likely as teeth have occasionally been found in the stomach and oesophagus of various turrids, and these can only have found their way there as the result of the prey containing the tooth responsible for its death, having been swallowed whole. The anesthetized prey is then, presumably, taken into the proboscis, which is capable of enormous distension, and transported whole into the distensible buccal tube and oesophagus."

The above description applies to those turrids, such as *Philbertia*, that have the true toxoglossate radula of detached marginal teeth. There must be considerable modification of the feeding mechanism and method for those turrids with the prototypic radula in which the teeth are fixed in serial rows upon a lingual ribbon.

A purely conjectural explanation of the possible transition from the prototypic to the truly toxoglossate state of the radula was recently given (Powell, 1966) and could be interpreted in the following way: the prototypic radula, as it occurs in situ, is tubular, with the marginals erect, parallel to the central, and in that position the marginals extend beyond both the central and the laterals. It would seem then that the

marginals administer the toxic fluid whilst the central and laterals serve in mastication. In the species that assume a more actively predaceous feeding method it is not difficult to visualise the transition of the marginals to the bundle of arrows fully toxoglossate state, at the expense of the masticatory teeth.

#### Stomach—

Smith (1967b) in his paper on the neogastropod stomach recorded that "in some species of muricids and buccinids there is an anterior migration

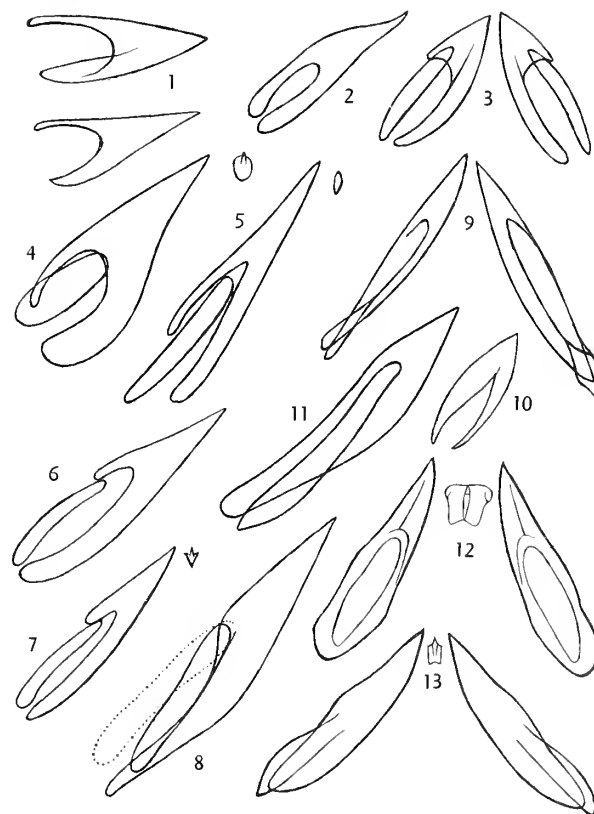


Plate 191. Radulae forms found in various turrids. Fig. 1, *Epidirona nodulosa* Laseron, 60-100 metres off Cronulla, New South Wales. Fig. 2, *Marshallleua nierstraszi* (Schepman), Arafura Sea, 1788 metres (after Schepman, 1913, Siboga Exped. Mono., 49, 1e, pl. 28, fig. 6c). Fig. 3, *Comitas onokeana vivens* Dell, New Zealand, 260 fathoms Chatham Rise (from Dell, 1956, Domin. Mus. Bull. No. 18, fig. 171). Fig. 4, *Turricula catena* (Reeve), Gulf of Oman. Fig. 5, *Turricula tornata fulminata* (Kiener), Mekran Coast. Fig. 6, *Knefastia dalli* Bartsch, Lower California. Fig. 7, *Knefastia funiculata* (Kiener), Gulf of California. Fig. 8, *Megasurcula remondii* (Gabb), California. Fig. 9, *Fusiturricula armilla* (Dall), West Mexico (Figs. 4-9 & 11, from drawings prepared by J. P. E. Morrison, United States National Museum, Washington). Fig. 10, *Iwaoa reticulata* Kuroda, 150 fathoms off Tosa, Japan (from Kuroda, Venus, 1953, 17 (4), fig. 9.). Fig. 11, *Leucosyrinx verrilli* (Dall), 734 fathoms off Guadeloupe. Fig. 12, *Clavatula rubrifasciata* (Reeve), West Africa. Fig. 13, *Clionella sinuata* (Born), South Africa (both from Thiele, 1925, Gast. deutsch. Tiefsee-Exped., Bd. 17, p. 204).



Plate 190. Cephalic features in the Turridae and Turriculinae. Fig. 1, *Turris babylonica* (Linnaeus), Philippines. Fig. 2, *Epidirona nodulosa* Laseron, New South Wales, 60-100 metres. Fig. 3, *Comitas onokeana vivens* Dell, New Zealand, 260 fathoms, Chatham Rise, showing the absence of eyes. Fig. 4, *Turricula javana* (Linnaeus), Philippines, showing the scalloped front margin of the head.

of the oesophageal opening which has been accompanied by a marked enlargement of the posterior region of the stomach. This posterior enlargement accentuates the anterior position of the oesophageal opening in these species. In other species, such as *Colus gracilis*, the oesophageal region of the stomach has been pulled anteriorly so that the stomach is now U-shaped. The gastric region of the Turridae is similarly U-shaped but this has been achieved by quite different means, namely, the loss of those regions of the stomach which lie posterior to the oesophageal opening. The above interpretation suggests that at least two trends are represented in the neogastropods."

#### *Reproductive system* –

Smith (1967c) in a paper on the reproductive system of British turrids remarked that although no definite phylogenetic conclusions were reached, the morphology of the turrid reproductive system suggested a parallel evolution to the Stenoglossa.

#### Subfamily Nomenclature

Objection may be taken to the use of the subfamily name Turriculinae Powell, 1942, since from a nomenclatural point of view it is homonymous with both the Turriculidae of Carpenter, 1861, and the Turriculinae of A. Adams, 1864. Carpenter's name was based upon *Turricula* Fabricius, 1823, a mitrid, not upon *Turricula* Schumacher, 1817, a turrid. Turriculinae A. Adams, 1864, refers to the same mitrid subfamily as Carpenter's proposition. Neither can be used in the Mitridae, since there is no nominal genus. For this mitrid subfamily, the name Vexillinae Thiele, 1929, is now in use (see Cernohorsky, 1966, Veliger, vol. 9, no. 2, p. 124).

The Turriculinae of Powell, 1942 was applied to a subfamily of the Turridae, but my later action (Powell, 1966, Bull. no. 5, Auck. Inst. Mus., p. 19) in removing *Acamptogenotia* Rovereto 1899 and its allies from the subfamily Conorbiinae and placing them in the Turriculinae, would normally make the name Pseudotominae Bellardi 1875 available. However, *Pseudotoma* Bellardi 1875 is a homonym of *Pseudotoma* Gray, 1825 and was re-named *Acamptogenotia* Rovereto, 1899. Thus by strict application of the rules the subfamily Turriculinae should be changed to the

Acamptogenotiinae; but this would be unfortunate, since the concept of the subfamily would be focused upon an atypical group.

Since Turriculinae Powell, 1942 was applied to a different family from both Carpenter's and Adams' propositions, both of which are now suppressed, there is no present name conflict, and so an application is being prepared to submit to the Commission on Zoological Nomenclature, advocating the validation of my 1942 proposition.

#### List of Recognized Taxa

Below are listed the recognized generic and subgeneric taxa for the Turriculinae, with species and subspecies.

This list follows that of the Turrinae, already published in this series (Vol. 1, no. 5, pp. 235-237 [p. 22-669] and no. 7, p. 409 [p. 23-101]). As before, taxa not represented in the Indo-Pacific are in square brackets, and with these the type species only is cited. Fossils are prefixed by a dagger (†). Where a species occurs both Recent and fossil the dagger occurs after the name.

Included in the list are southern Australian and New Zealand Recent and Tertiary Turriculinae. Such species are not excluded, since they have had an Indo-Pacific origin during past periods of the Tertiary when warm waters extended farther south than they do at present. Also included are some Japanese species of *Aforia*, although their occurrence in that area is at considerable depths, associated with cold bottom waters, in locations where the warmer shallow waters support a temperate to subtropical fauna.

#### Subfamily Turriculinae

##### *Turricula* Schumacher, 1817

*aethiopica* (Thiele, 1925)

†*blagrovei* (Vredenberg, 1921)

*catena* (Reeve, 1843)

*ceylonica* (E. A. Smith, 1877)

†*culleni* (Dey, 1962)

*gemmaeformis* (Thiele, 1925)

†*hillegondae* (K. Martin, 1914)

†*jogjacartensis* (K. Martin, 1931)

*javana* (Linnaeus, 1767)

†subsp. *tegalensis* (K. Martin, 1895)

†*kelirensis* (K. Martin, 1916)

†*lepidota* (K. Martin, 1914)

†*nanggulanensis* (K. Martin, 1931)



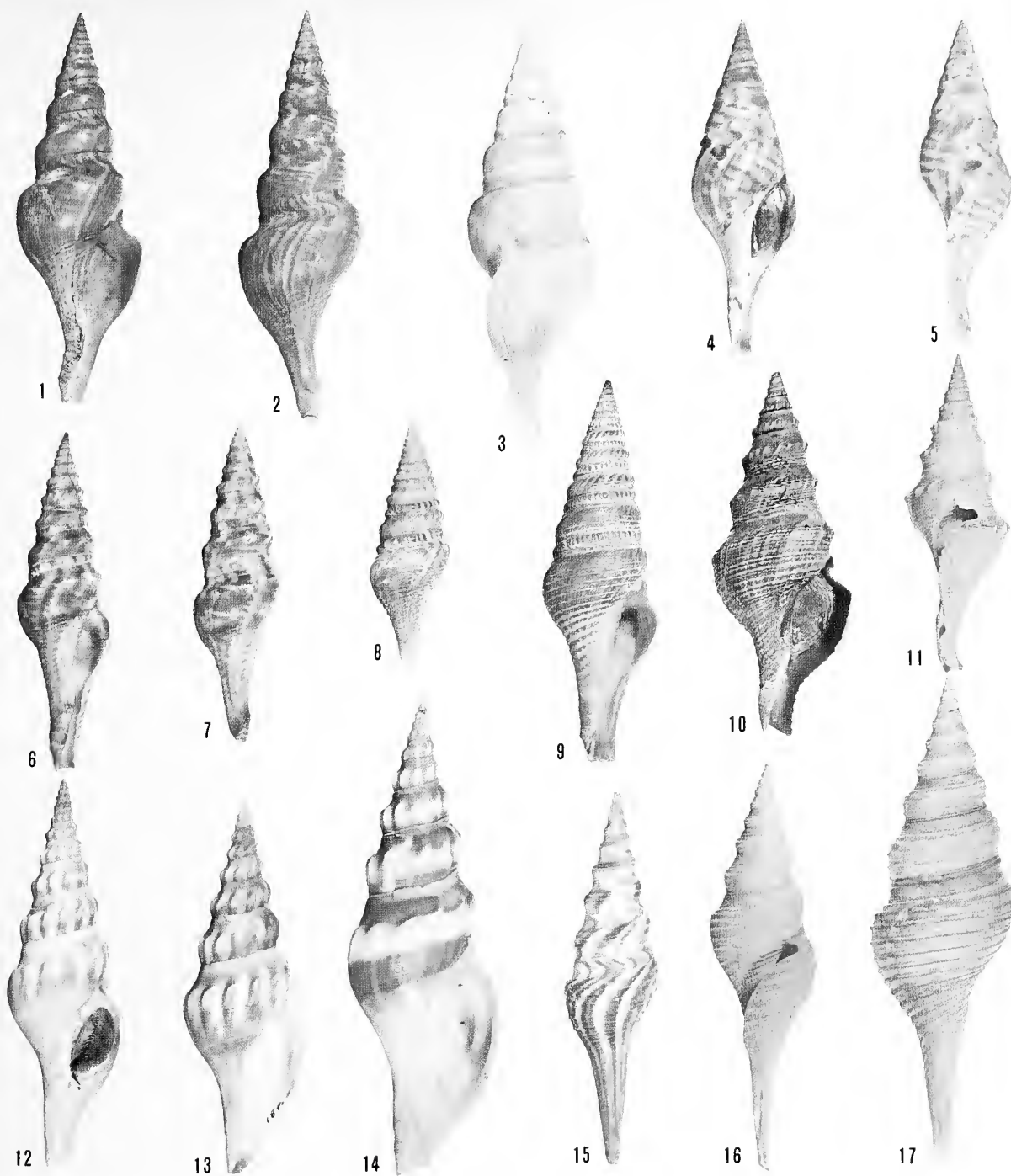


Plate 192

Fig. 1,2. *Turricula tornata* (Dillwyn). India (see text, p. 23-226).

3. *Turricula tornata* (Dillwyn). Madras, India

4,5. *Turricula tornata fulminata* (Kiener). Kuh-i-Mubarik, Gulf of Oman (p. 23-227).

6,7. *Turricula catena* (Reeve). Muscat, 40 fathoms (p. 23-228).

8,9. *Turricula navarchus* (Melvill & Standen). Between Charbar and Jask, Gulf of Oman, 200 fathoms (p. 23-228).

10. *Turricula javana* (Linnaeus). Bombay, India (p. 23-229).

11. *Turricula javana* (Linnaeus). China Seas

12,13. *Comitas kaderlyi* (Lischke). Off Tosa, Japan

14. *Comitas kaderlyi* (Lischke). Wakayama, Japan, 50 fathoms (p. 23-277).

15. *Nihonia mirabilis* (Sowerby). Off Tosa, Japan (p. 23-387).

16,17. *Nihonia australis* (Gmelin). China Seas (p. 23-387).

(all 5/6 natural size)

*navarchus* (Melvill & Standen, 1903)  
*nelliae* (E. A. Smith, 1877)  
 subsp. *granobalteus* (Hedley, 1922)  
 subsp. *spurius* (Hedley, 1922)  
*paupera* (Watson, 1881)  
†*plagiaria* (K. Martin, 1931)  
†*praeepromensis* Eames, 1952  
*profundorum* (E. A. Smith, 1896)  
†*promensis* (Vredenburg, 1921)  
†*samarangana* (K. Martin, 1884)  
†*sethuramae* (Vredenburg, 1921)  
*sumatrana* (Thiele, 1925)  
†*terae* Oostingh, 1938  
†*thangaensis* (Vredenburg, 1921)  
*thurstoni* (E. A. Smith, 1896)  
*tornata* (Dillwyn, 1817). *Type*  
 †subsp. *atjehensis* Oostingh, 1938  
 subsp. *fulminata* (Kiener, 1839-40)  
†*voyseyi* (d'Archiac & Haime, 1854)  
†*wanneri* (K. Martin, 1914)

(provisional placement)

*amplisulcus* (Barnard, 1958)  
†*bantamensis* (K. Martin, 1895)  
*biconica* (Schepman, 1913)  
†*drilliaeformis* (K. Martin, 1895)  
†*everwijni* (K. Martin, 1884)  
*faurei* (Barnard, 1958)  
†*gembacana* (K. Martin, 1884)  
†*indica* (Cossmann & Pissarro, 1909)  
*obliquicostata* (von Martens, 1901)  
†*pollii* (Icke & Martin, 1907)  
*pulchra* (Schepman, 1913)  
*scalaria* (Barnard, 1958)  
†*smithi* (K. Martin, 1884)  
*sulcicancellata* (Barnard, 1958)  
†*waringinensis* (K. Martin, 1895)

*Comitas* Finlay, 1926

†*abnormis* King, 1933  
*aequatorialis* (Thiele, 1925)  
 subsp. *palawanica* Powell, new  
 subspecies  
*albicineta* (Adams & Reeve, 1850)  
†*allani* Powell, 1942  
*anteridion* (Watson, 1881)  
*arcana* (E. A. Smith, 1899)  
†*atsukoe* (Kamada, 1962)  
†*bilix* Marwick, 1931  
*breviplicata* (E. A. Smith, 1899)  
*chuni* (von Martens, 1902)  
†*crenulariodes* (Pritchard, 1896)  
†*declivis* Powell, 1931  
†*dijki* (K. Martin, 1884)

*erica* (Thiele, 1925)  
*eurina* (E. A. Smith, 1899)  
*exstructa* (von Martens, 1903)  
†*fusiformis* (Hutton, 1877). *Type*  
*galathea* Powell, new species  
†*habei* Shuto, 1961  
†*imperfecta* King, 1933  
*kaderlyi* (Lischke, 1872)  
†*kaipara* Laws, 1939  
*kamakurana* (Pilsbry, 1895)  
†*kayalensis* (Dey, 1962)  
*kirai* Powell, new species  
*kuroharai* Oyama, 1962  
†*lutescens* (Hutton, 1873)  
†*latiaxialis* (Marshall, 1918)  
*lurida* (Adams & Reeve, 1850)  
*luzonica* Powell, new species  
*malayana* (Thiele, 1925)  
*margaritae* (E. A. Smith, 1904)  
*melvilli* (Schepman, 1913)  
†*miyazakiensis* Shuto, 1961  
*murrawolga* Garrard, 1961  
*obtusigemmata* (Schepman, 1913)  
*oahnensis* Powell, new species  
†*onokeana* King, 1933  
 subsp. *vivens* Dell, 1956  
*pagodaeformis* (Schepman, 1913)  
†*pseudoclarae* Powell, 1944  
*rotundata* (Watson, 1881)  
*saldanhae* (Barnard, 1958)  
†*salebrosa* (Harris, 1897)  
*sibogae* (Schepman, 1913)  
†*sobrina* (Yokoyama, 1923)  
†*sobrinaeformis* (Nomura, 1937)  
†*solitaria* (King, 1933)  
*stolida* (Hinds, 1843)  
*subsuturalis* (von Martens, 1902)  
*suluensis* Powell, new species  
*sympbiotes* (Wood-Mason & Alcock, 1891)  
 subsp. *subcorpulenta* (E. A. Smith, 1894)  
*subcorpulenta* (E. A. Smith, 1894)  
†*terrisae* Vella, 1954  
*thisbe* (E. A. Smith, 1906)  
 subsp. *diomedea* Powell, new subspecies  
†*torquayensis* Powell, 1944

*trailli* (Hutton, 1873)  
*undosa* (Schepman, 1913)  
*variabilis* (Schepman, 1913)  
†*yokoyamai* (Otuka, 1934)  
†*wynyardsensis* (Pritchard, 1896)

Subgenus *Pseudofusia* Shuto, 1969

†*dinglensis* (Shuto, 1969). *Type*

**Group of *Comitas clarae***

- †*aldingensis* Powell, 1944
- †*clarae* (Tenison-Woods, 1880)
- †*subcarinapex* Powell, 1942  
(provisional placement)
- †*buxtorfi* (K. Martin, 1914)
- †*halicyria* (Melvill, 1904)
- †*hillegondae* (K. Martin, 1931)
- †*lanta* (Thiele, 1925)
- †*makiyamae* (Shuto, 1961)
- †*mertoni* (K. Martin, 1914)
- †*mordax* (K. Martin, 1914)
- †*opulenta* (Thiele, 1925)

**Anticomitas** Powell, 1942  
†*vivens* Powell, 1942. Type

**Paracomitas** Powell, 1942  
†*augusta* (Murdoch & Suter, 1906)  
†*castlecliffensis* (Marshall & Murdoch, 1919). Type  
†*gemmea* (Murdoch, 1900)  
†*gypsata* (Watson, 1881)  
†*protransenna* (Marshall & Murdoch, 1923)  
†*rodgersi* MacNeil, 1960

**Antimelatoma** Powell, 1942  
†*ahiparana* Powell, 1942  
†*benthicola* Powell, 1942  
†*buchanani* (Hutton, 1873)  
subsp. *maorum* (E. A. Smith, 1877). Type  
†*canyonensis* Dell, 1956

†[*Catenotoma* Cossmann & Pissarro, 1900]

†[*catenata* (Lamarck, 1804)]. Type

†**Tholitoma** Finlay & Marwick, 1937  
†*dolorosa* Finlay & Marwick, 1937. Type

†**Pleurofusua** Gregorio, 1890  
†*amphibola* Cossmann & Pissarro, 1909  
†*feddeni* (Noetling, 1895)  
†*fusus* Vredenburg, 1921  
†*hanguensis* Cox, 1930  
†*iravadica* Vredenburg, 1921  
†[*longirostropis* Gregorio, 1890]. Type  
†*obliquinodosa* Eames, 1952  
†*phasma* Vredenburg, 1921  
†*pseudoscala* Eames, 1952  
†*scala* Vredenburg, 1921

[**Fusiturricula** Woodring, 1928]  
†[*fusinella* Dall, 1908]. Type  
Subgenus [**Fusisyrinx** Bartsch, 1934]  
†[*fenimorei* Bartsch, 1934]. Type

†[**Crenaturricula** Vokes, 1939]  
†[*crenatospira* (Cooper, 1894)]. Type

†[**Cruziturricula** Marks, 1951]  
†[*cruziana* (Olsson, 1932)]. Type

**Makiyamaia** MacNeil, 1960†  
†*aritaensis* Shuto & Ueda, 1963  
†*coreanica* (Adams & Reeve, 1850). Type  
†subsp. *okinavensis* MacNeil, 1960  
†*kurodae* Shuto & Ueda, 1963  
†*subdeclivis* (Yokoyama, 1926)†  
†subsp. *acuticarinata* (Shuto, 1961)

**Paradrillia** Makiyama, 1940†  
†*agalma* (E. A. Smith, 1906)  
†*alluaudi* (Dautzenberg, 1932)  
†*astuta* (Yokoyama, 1928)  
†*astutoida* Shuto, 1961  
†*boehmi* (K. Martin, 1914)  
†*celebensis* (Schepman, 1913)  
†*convexiuscula* Shuto, 1961  
†*dainichiensis* (Yokoyama, 1923)†. Type  
†*djocdjocartae* (K. Martin, 1884)  
†subsp. *serana* (P. J. Fischer, 1927)  
†*ermelingi* (K. Martin, 1884)  
†*himea* (Makiyama, 1927)  
†*inconstans* (E. A. Smith, 1875)  
subsp. *prunulum* (Melvill & Standen, 1901)  
†*prunulum* (Melvill & Standen, 1901)  
†*kakegawaensis* (Makiyama, 1927)  
†*lithoria* (Melvill & Standen, 1903)  
†*melvilli* Powell, new species  
†*minoensis* Shuto, 1961  
†*nivalioides* (Yokoyama, 1920)  
†*patruelis* (E. A. Smith, 1875)  
†*taiwanensis* (Nomura, 1935)

**Vexitomina** Powell, 1942  
†*coriorudis* (Hedley, 1922)  
†*coxi* (Angas, 1867)  
†*garrardi* Laseron, 1954  
†*metcalfei* (Angas, 1867). Type  
†*optabilis* (Murdoch & Suter, 1906)  
†*pilazona* Laseron, 1954  
†*regia* (Reeve, 1842)  
†*suavis* (E. A. Smith, 1888)  
†*torquata* Laseron, 1954



- †[*Orthosurcula* Casey, 1904]  
 †[*longiforma* (Aldrich, 1897)]. **Type**
- Nihonia** MacNeil, 1960  
*australis* (Roissy, 1805)  
 †*birmanica* (Vredenburg, 1921)  
*circumstricta* (von Martens, 1901)  
*mirabilis* (Sowerby, 1914)  
 †*pervirgo* (Yokoyama, 1928)  
 †*shimajiriensis* MacNeil, 1960. **Type**  
 †*santosi* Shuto, 1969  
 †*soyomaruuae* (Otuka, 1959)  
 †subsp. *takanabensis* (Otuka, 1959)  
 †*sucabumiana* (K. Martin, 1895)
- Leucosyrinx** Dall, 1889  
 [verilli (Dall, 1881)]. **Type**  
*caecilia* Thiele, 1925  
*crispulata* (von Martens, 1901)  
*elsa* Thiele, 1925  
*erna* Thiele, 1925  
 †*iwaensis* MacNeil, 1960  
*julia* Thiele, 1925  
*pikei* (Dell, 1963)  
*queenslandica* Powell **new species**  
*sansibarica* Thiele, 1925  
*suratensis* (Thiele, 1925)
- Sibogasyrinx** Powell, new subgenus  
*archibenthalis* Powell **new species**  
*pyramidalis* (Schepman, 1913). **Type**
- Apiotoma** Cossmann, 1889†  
 †[*pirulata* (Deshayes, 1834)]. **Type**  
 †*arntzenii* K. Martin, 1931  
 †*balcombensis* Powell, 1944  
 †*bassi* Pritchard, 1904  
 †*chapplei* Powell, 1944  
 †*deningeri* (K. Martin, 1914)  
 †*grauti* (Pritchard, 1904)  
 †*haydeni* (Cox, 1930)  
 †*janjukiensis* (Chapple, 1934)  
 †*pritchardi* Powell, 1944  
*tibiaformis* Powell, **new species**  
 subsp. *sibukoensis* Powell **new sub-species**  
 †*vredenburgi* (Cossmann & Pissarro, 1909)
- †**Zemacies** Finlay, 1926  
 †*armata* Powell, 1942  
 †*awakinoensis* Powell, 1942  
 †*climacota* (Suter, 1917)  
 †*elatior* Finlay, 1926. **Type**
- †*gravida* (Marshall, 1919)  
 †*hamiltoni* (Hutton, 1905)  
 †*immatura* Finlay & Marwick, 1937  
 †*inexpectata* Powell, 1944  
 †*lividorupis* Laws, 1935  
 †*marginalis* (Marshall, 1919)  
 †*ordinaria* (Marshall, 1918)  
 †*prendrevillei* Marwick, 1928  
 †*simulacrum* Laws, 1935  
 †*torticostata* (Marshall, 1919)
- †**Insolentia** Finlay, 1926  
 †*elegantula* Powell, 1942  
 †*famelica* Marwick, 1931  
 †*inaequalis* Marwick, 1931  
 †*johnstoni* (Tenison-Woods, 1877)  
 †*laciniata* (Suter, 1917)  
 †*pareoraensis* (Suter, 1907). **Type**  
 †*seminuda* (Suter, 1917)  
 †*sertula* (Suter, 1917)
- Typhlosyrinx** Thiele, 1925  
*praecipua* (E. A. Smith, 1899)  
*supracostata* (Schepman, 1913)  
*vepallida* (von Martens, 1902). **Type**
- Clavosurcula** Schepman, 1913  
*sibogae* Schepman, 1913. **Type**
- Belaturricula** Powell, 1951  
*dissimilis* (Watson, 1886)  
 [turrita (Strebel, 1908)]. **Type**
- Austrocarina** Laseron, 1954  
*recta* (Hedley, 1903). **Type**
- [**Knefastia** Dall, 1919]  
 [olivacea (Sowerby, 1834)]. **Type**
- †[**Eosurcula** Casey, 1904]  
 †[moorei Gabb, 1860]. **Type**
- †[**Leptosurcula** Casey, 1904]  
 †[beadata (Harris, 1895)]. **Type**
- †[**Protosurcula** Casey, 1904]  
 †[gabbii (Conrad, 1865)]. **Type**
- †[**Hemisurcula** Casey, 1904]  
 †[silicata (Aldrich, 1895)]. **Type**
- Marshallena** Allan, 1926†  
 †*anomala* Powell, 1942  
 †*austrotomoides* Powell, 1931

- carinaria* Powell, 1935  
 †*celsa* Marshall, 1931  
 †*curtata* (Marwick, 1926)  
 †*decens* Marwick, 1931  
*diomedea* Powell, new species  
 †*esdailei* (Marwick, 1926)  
*gracilispira* Powell, new species  
 †*impar* Powell, 1942  
*lepta* (Watson, 1881)  
 †*neozelanica* (Suter, 1917). Type  
*nierstraszi* (Schepman, 1913)  
*philippinarum* (Watson, 1882)  
 †*serotina* (Suter, 1917)
- Iwaoa Kuroda, 1953  
*reticulata* Kuroda, 1953. Type
- †*Marshallaria* Finlay & Marwick, 1937  
 †*formosa* (Allan, 1926)  
 †*multicincta* (Marshall, 1917)  
 †*senilis* (Marshall & Murdoch, 1920)  
 †*senta* Powell, 1942  
 †*spiralis* (Allan, 1926). Type  
 †*tuttleyi* (Allan, 1926)  
 †*waitakiensis* Powell, 1942
- †*Notogenota* Powell, 1942  
 †*finlayi* Powell, 1942  
 †*goniodes* (Suter, 1917). Type  
 †*pahiensis* Powell, 1942
- †*Austrotoma* Finlay, 1924  
 †*ampla* Powell, 1942  
 †*clifdenica* Powell, 1942  
 †*cryptoconoidea* Powell, 1942  
 †*deducta* Marwick, 1931  
 †*echinata* Powell, 1942  
 †*excavata* (Suter, 1917). Type  
 †*eximia* (Suter, 1917)  
 †*finlayi* Powell, 1938  
 †*gemmulata* Powell, 1942  
 †*gracilicostata* (Zittel, 1865)  
 †*hurupiensis* Dell, 1952  
 †*inaequabilis* Marwick, 1929  
 †*indiscreta* Finlay & Marwick, 1937  
 †*inexpectata* Powell, 1944  
 †*jaujukiensis* Powell, 1944  
 †*kaiparaensis* Powell, 1942  
 †*lawsi* Powell, 1942  
 †*minor* (Finlay, 1924)  
 †*molinei* Marwick, 1931  
 †*neozelanica* (Suter, 1913)  
 †*nervosa* Powell, 1942  
 †*obsoleta* Finlay, 1926
- †*prolixa* Laws, 1940  
 †*toreuma* Marwick, 1929
- †*Belophos* Cossmann, 1901  
 †*woodsii* (Tate, 1888). Type
- †*Belatomina* Powell, 1942  
 †*clathrata* Powell, 1944  
 †*pulchra* (Tate, 1888). Type  
 †*tenuisculpta* (Tenison-Woods, 1877)
- †*Liratomina* Powell, 1942  
 †*adelaidensis* Powell, 1944  
 †*crassilirata* (Tate, 1888)  
 †*intertexta* Powell, 1944  
 †*sculptilis* (Tate, 1888). Type  
 †[*Acamptogenotia* Rovereto, 1899]  
 †[*intorta* (Brocchi, 1814)]. Type
- [Megasurcula Casey, 1904]†  
 [carpenteriana (Gabb, 1865)]. Type
- [Pseudomelatoma Dall, 1918]†  
 [penicillata (Carpenter, 1865)]. Type
- [Hormospira Berry, 1958]  
 [maculosa (Sowerby, 1834)]. Type
- †[Amuletum Stephenson, 1941]  
 †[macnairyeusis (Wade, 1926)]. Type  
 Subgenus †*Lutema* Stephenson, 1941]  
 †[simpsonensis Stephenson, 1941]. Type
- †[Beretra Stephenson, 1941]  
 †[firma Stephenson, 1941]. Type  
 †[Fusimilis Stephenson, 1941]  
 †[robustus Stephenson, 1941]. Type  
 †[Remnita Stephenson, 1941]  
 †[biacuminata (Wade, 1926)]. Type
- †*Tahusyrinx* Powell, 1942  
 †*maorum* (Marshall & Murdoch, 1923). Type
- †*Parasyrinx* Finlay, 1924  
 †*alta* (Harris, 1897). Type  
 †*subalta* (Marshall & Murdoch, 1919)
- Subgenus †*Lirasyrinx* Powell, 1942.  
 †*anomala* (Powell, 1942). Type
- †*Cosmasyrinx* Marwick, 1931  
 †*ardua* Marwick, 1931  
 †*latior* Marwick, 1931  
 †*monilifera* Marwick, 1931. Type  
 †*semilirata* Powell, 1942  
 †*tereumera* Marwick, 1931

- †[*Cochlespiropsis* Casey, 1904]  
 †[*engonata* (Conrad, 1865)]. Type

*Cochlespira* Conrad, 1865†  
*beuteli* Powell, new species  
 †[*cristata* (Conrad, 1847)]. Type  
*kuroharae* (Kuroda, 1959)  
 †*osawanoensis* (Tsuda, 1959)  
*pulchella* (Schepman, 1913)  
 †subsp. *cornetiformis* (Tesch, 1915)  
 subsp. *fossata* Powell, new subspecies  
 subsp. *pulcherrissima* (Kuroda, 1959)  
 subsp. *semipolita* Powell, new subspecies  
 †*semitiplana* (Powell, 1944)  
*simillima* Powell, new species  
 †*takabanarensis* (MacNeil, 1960)  
*travancorica* (E. A. Smith, 1896)  
 forma *granulata* (E. A. Smith, 1904)  
 †*venusta* (Powell, 1944)

*Thatcheriasyrinx* Powell new genus  
*orientis* (Melvill, 1904). Type  
 subsp. *kawamurai* (Kuroda, 1959)

*Aforia* Dall, 1889  
*circinata* (Dall, 1873). Type  
*japonica* Bartsch, 1945  
 ?†*otohime* (Ozaki, 1958)

[*Steiraxis* Dall, 1895]  
 [ *aulaca* (Dall, 1895)]. Type

#### Doubtful or Rejected Taxa Possibly Turriculinae

*Bathybela* Kobelt, 1905, Iconogr. Schalentr. Europ. Meeresconch, vol. 3, p. 275. Type: by subsequent designation, Dall, 1918: *Thesbia nudator* Locard, 1897. Type locality: off Azores, 4010-4060 metres.

*Belomitra* P. Fischer, 1882, Journ. de Conchyl., vol. 30, p. 275. Type: by monotypy: *Belomitra paradoxa* P. Fischer, 1882. Type locality: Atlantic, 627 metres. (This genus may be buccinid.)

*Cochlespirella* Casey, 1904, Proc. Acad. Nat. Sci. Philadelphia, vol. 55, p. 279. Type: by original designation: *Fusus nanus* Lea, 1833. Type locality: Claiborne Eocene of Alabama.

*Laevitectum* Dall, 1919, Proc. U. S. Nat. Mus., vol. 56, no. 2288, p. 19. Type: by original designation: *Drillia eburnea* Carpenter, 1865. Type locality: Gulf of California. Possibly a subgenus of *Pseudomelatomia* Dall. (Powell, Bull. no. 5, Auck. Inst. Mus., p. 33).

*Lyrosurcula* Casey, 1904, Trans. Acad. Sci. St. Louis, vol. 14, no. 5, p. 156. Type: by subsequent designation; Powell, 1942: *Lyrosurcula elegans* Casey, 1904. Type locality: Claiborne Eocene of Louisiana.

*Microsurcula* Casey, 1904, Trans. Acad. Sci. St. Louis, vol. 14, no. 5, p. 154. Type: by original designation: *Microsurcula nucleola* Casey, 1904. Type locality: Claiborne Eocene of Louisiana.

*Rhodopetoma* Bartsch, 1944, Proc. Biol. Soc. Washington, vol. 57, p. 59. Type: by original designation: *Borsonella rhodope* Dall, 1919. Type locality, off Santa Rosa, California, 82 fathoms. (The radular evidence points to the Turriculinae rather than to the Borsoniinae; Powell, 1966, Bull. no. 5, Auck. Inst. Mus., p. 32).

*Scalaturris* Brébion, 1954, Bull. Mus. d 'Hist. Nat. Paris, sec., 2, vol. 25, pt. 6, p. 645. Type: by original designation: *Scalaturris riedeli* Brébion, 1954. Type locality: Senonian Cretaceous of Cameroons, West Africa.

*Stenodrillia* Korobkov, 1955, (subgenus of *Drillia*) Handb. and methodical Guide to the Tertiary Mollusca; Gastropoda, p. 392. Leningrad (in Russian). Type: by original designation: *Drillia allionii* Bellardi, 1877. Type locality: Pliocene of Italy. (Resembles *Comitas*).

*Struthiolariopsis* Wilckens, 1904, Revis. der Fauna der Quiriquina Schichten, Neu Jahrb. fur Min., vol. 18, p. 208. Type: by monotypy: *Fusus perrieri* Philippi, 1887. Type locality: Cretaceous of Quiriquina, Chile. (Probably nearest allied to *Austrotoma*).



*Sullivania* Harris and Palmer, 1947, Bull. Amer. Paleont., vol. 30, no. 117, p. 432.

**Type:** by original designation: *Pleurotoma perexilis* Aldrich, 1886. Type locality: Claiborne and Jackson Eocene of the southern United States. (Close to *Hemisurcula*).

*Surculoma* Casey, 1904, Trans. Acad. Sci. St. Louis, vol. 14, p. 153. **Type:** by original designation: *Pleurotoma tabulata* Conrad, 1833. Type locality: Claiborne Eocene of Alabama. Synonym, *Volutapex* Harris, 1937, Palaeontogr. Amer., vol. 2, no. 7, p. 55. **Type:** by original designation: *Surcula calautica* Harris, 1937. Type locality: Claiborne Eocene of Alabama.

*Surcula bawangana* (Boettger) K. Martin, 1914, Samml. Geol. Reichs-Mus., Leiden, vol. 2 no. 4, pl. 2, figs. 51a, b. Nanggulan beds, Miocene of Java. Judged from Martin's 1914 figure of this shell, it is not at all certain that the species is turriculinid; it may be even a clavinid, possibly *Iuquisitor*.

#### Removed from Turriculinae

*Geutotia* (*Pseudotoma*) *pseudomelongena* K. Martin, 1914, Samml. Geol. Reichs-Mus., Leiden, vol. 2, no. 4, p. 112, pl. 4, figs. 101, a, b. Nanggulan beds, Miocene of Kali Puru, Java. This species is certainly not a turrid, for there is not a true sinus; the entering parietal tubercle, and general facies suggest a neptunid, not unlike *Siphonalia*.

*Pleurotoma* (*Pyranitoma*) *puruensis* K. Martin, 1914, Samml. Geol. Reichs-Mus., Leiden, vol. 2, no. 4, p. 118, pl. 1, figs. 30, 31 (section and species nov.). Nanggulan beds, Miocene of Java. This shell is probably not a turrid; it has more the appearance of a latirid.

*Surculina* Dall, 1908, Bull. Mus. Comp. Zool., vol. 43, no. 6, p. 260. **Type:** by original designation: *Daphnella* (*Surculina*) *blanda* Dall, 1908. Type locality: Cocos Island, Gulf of Panama, 1067 fathoms. This genus has had several subfamily locations in the Turridae: originally in the *Daphnellinae*, as a subgenus of *Leucosyrinx* (Turriculinae) (Grant and Gale,

1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 509), in the Cochlespirinae (=Turriculinae) (Powell, 1942, Bull. no. 2, Auck. Inst. Mus., p. 21), and again in the Daphnellinae (Powell, 1966, Bull. no. 2, Auck. Inst. Mus., p. 21), and again in the Daphnellinae (Powell, 1966, Bull. no. 5, Auck. Inst. Mus., p. 137), and finally, Rehder (1967, Pacific Science, vol. 21, no. 2, p. 184) has shown that the genus must be removed from the Turridae and placed in the Turbinellidae (=Xancidae).

*Drillia aemula* Angas, 1877. Proc. Zool. Soc., London, p. 36, pl. 5, fig. 9. New South Wales, Port Jackson. Type in the British Museum (Natural History). This species also has not been recognised by Australian conchologists. Hedley, 1913 (Proc. Linn. Soc. N. S. W., vol. 38, pt. 2, p. 311, pl. 19, fig. 77) considered it to be a synonym of the New Zealand *Comitas trilli* (Hutton, 1873), which it certainly is not. It is in fact a *Crassispira* and appears closely allied to some Philippine species to be dealt with later. Macpherson & Gabriel, 1962, Marine Molluscs of Victoria, p. 232 refer *aemula* to *Vexitomina*.

*Surcula brachytoma* Schepman, 1913. Siboga Exped. vol. 49, pt. 1e, p. 424, pl. 27, fig. 11 (Timor Sea, 828 metres). It is very doubtful if this species is a turrid, for there is no semblance of a posterior sinus, but what does appear to be certain is that there is an allied species in *Pleurotoma* (*Clionella*) *quadruplex* Watson, 1881 (Journ. Linn. Soc., vol. 16, p. 253) from west of the Azores in 1000 fathoms. These shells are slender and subcylindrical, with a tall spire and truncated anterior end. They are of mitrid or cancellarid appearance but lack the characteristic pillar plaits of both these families. The protoconch, unknown in the two above mentioned species, is now shown by Philippine material of Schepman's species from 494 and 565 fathoms, respectively (Albatross Sta. 5236 and 5460, USNM.) to be moderately large of 1½ smooth, subglobose whorls, with the tip asymmetric. Schepman's species is 47 × 12.5 mm. and Watson's 48.5 × 13 mm. A shell from 463 metres off Zanzibar, *Maugelia?* *paschalis* Thiele, 1925 (Deutsch. Tiefsee-Exped., vol. 17 no. 2, p. 244, pl. 26, fig. 23), appears to be identical with Schepman's *brachytoma*. The stronger subsutural gemmules shown in Thiele's figure,

which is based upon a small shell, can be matched upon the early whorls of *brachytoma*.

Watson's species was made the type of the genus *Bathyclionella* Kobelt, 1905, but the family location of the genus remains problematic. If the genus is turrid, and that cannot be claimed with certainty without study of animals not yet available, it could be an aberrant member of the Daphnellinae, comparable with *Teleochilus*, but not necessarily closely related to that genus. The presence of one or two very weak plicae at the end of the pillar recalls such a feature in some species of *Daphnella*.

*Surcula gerthi* K. Martin, 1931. Mollusken aus dem Obereocan von Nanggulan, Mijnbouw Nederlandsch-Indie, Wetens. Meded., No. 18, p. 6, pl. 1, figs. 13, 13a. Java, Kali Puru (Nanggulan, Miocene). This species, known to me only from the original figures and description, appears to be clavinid rather than turriculid. The sinus is restricted to a deep narrow U-shape by a broad but ill defined subsutural fold and the illustration indicates a strong upper-parietal callus pad.

*Pleurotoma (Clavus) lignaria* Sowerby, 1903. Marine Invest. S. Africa, vol. 2, p. 215, pl. 3, fig. 4. (South Africa, Lion's Head, 136 fathoms). This species was assigned to *Turris* by Barnard (1958, Ann. S. Afr. Mus., vol. 44, p. 102), who stated that it was very close to *stolida* (Hinds, 1844). Hind's species, however, is a *Comitas*, but Sowerby's *lignaria*, judged from the original figures, is not related but belongs to the Clavinae, on the evidence of an apparent parietal callus-pad and a rather deeply notched very short anterior canal.

*Surcula macilenta* Melvill, 1923. Proc. Malac. Soc., vol. 15, p. 168, pl. 5, fig. 13 (South Africa). Non *Murex macilentus* Solander, 1766; see *Turris (Surcula) macella* Melvill, 1923, Proc. Malac. Soc., vol. 15, p. 309, *nom. nov.* This new name was unnecessary, for Barnard (1958, Ann. S. African Mus., vol. 44, p. 125) relegated *macilenta* to the synonymy of *Drillia platystoma* (Smith, 1877), a species already referred, probably more correctly, to *Clionella* by Bartsch (1915, U. S. Nat. Mus. Bull. 91, p. 18).

*Pleurotoma karenica* Noetling, 1901, Palaeont. Indica., new series, vol. 1, no. 3, p. 344, pl. 22, figs. 21, 21a. Burma, Kama series, Miocene. It is impossible to tell from the original description and figures if this is a turrid or a turriculid, since there is no reference to the posterior sinus. The species was compared with *Gemmula kieneri* (Doumet) by Noetling (1901), but Vredenburg (1921) placed the species in *Surcula* (= *Turricula*).

*Pleurotoma (Surcula) pamotanensis* K. Martin, 1906. Die Foss. von Java, Samml. Geol. Reichs-Mus., Leiden, Neue Folge, vol. 1, pt. 9, p. 292, pl. 43, fig. 701. (Java, Rembang Beds, Aquitanian, Miocene). From the original figure this species appears to be Clavinid. The sinus is deep, U-shaped, with a raised rim, and is restricted above by a strong subsutural fold. There is a well developed parietal callus pad, and the relatively short anterior end is robust, with a prominent fasciole and false umbilical chink, similar to those in typical *Drillia*.

*Surcula permodesta* K. Martin, 1914. Die Fauna des Obereocäns von Nanggulan auf Java, Samml. Geol. Reichs-Mus., Leiden, Neue Folge, vol. 2, pt. 4, p. 118, pl. 1, fig. 27. (Java, Kali Puru, Nanggulan Beds, Miocene). This rather small shell, 20 mm. ( $\frac{3}{4}$  inch) in height, somewhat resembles *Pleurotoma tjibaliungensis* Martin, 1895, which appears to be clavinid. The spire-whorls are smooth except for very distant broad, low axial folds, which commence weakly over the penultimate and then gain rapidly in strength. These axials are about six per whorl, and they commence above in slightly pinched or peaked form at the lower edge of a weak shoulder sulcus. Below, the axials broaden, flatten out and become obsolete just below aperture level. There is no submargining of the suture, and the only other surface sculpture is in the form of axial growth lines, which are distinct only over the shoulder sulcus, where they define successive broadly arcuate curves of the sinus.

*Pleurotoma (Surgula) radulaeformis* Weinkauff, 1876. Conch. Cab., p. 91, pl. 19, figs. 7, 8. Tasmania, Bass Strait. Type probably in the Godffroy Museum, Hamburg. This species is unknown to Australian conchologists, nor has it

been recognised from elsewhere. Hedley, 1922 (Rec. Aust. Mus. vol. 13 no. 6, p. 245) suggested apparent resemblance to *Vexitomina metcalfei* (Angas, 1878).

*Pleurotoma (Surcula) rembangensis* K. Martin, 1906, Die Fossilien von Java, Samml. Geol. Reichs-Mus., Leiden, Neue Folge, vol. 1, p. 293, pl. 43, fig. 702. Rembang beds, lower Miocene of Java. From the figures it is difficult to assign this species generically, but it could be a *Clavatula*, or even more likely a *Perrona*, for the whorls are noticeably adpressed at the suture, and the spire outlines are almost straight.

*Surcula streptopleura* Cossmann, 1900. Journ. de Conch., vol. 48, p. 35, pl. 3, fig. 18 (Southern India, Karikal, Pliocene). This small shell ( $8 \times 3.5$  mm.), with a badly damaged and incomplete body-whorl, is characterised by widely spaced axials, which line up in continuous very protractively oblique series from whorl to whorl. It is doubtfully turriculid.

*Pleurotoma subdeclivis striato-tuberculata* Yokoyama, 1928. Journ. Fac. Sci. Imper. Univ. Tokyo, Sect. 2, vol. 2, no. 7, p. 340, pl. 66, fig. 6 (Japan, Kounji, Pliocene). Yokoyama's figures show very clearly that his species has a peripheral sinus and is therefore quite remote from either *Turricula* or *Makiyamaia*. It is in fact a *Micantapex*.

*Surcula timorensis* Schepman, 1913. Siboga Exped. vol. 49, pt. 1e, p. 423, pl. 27, fig. 9 (Timor Sea, 918 metres). This shell has the general appearance of a clavinid rather than a turriculid, except for the presence of a faint spiral fold just above middle height on the columella. Schepman mentioned the possibility of the shell being borsonid but had some doubt regarding the fold, as shown by his remark, "may it be accidental?". However since *Borsonia ochracea* Thiele, 1925, from off the Somali coast in 1644 metres, a somewhat similar shell, has the pillar plait as a constant feature, there is no reason to doubt reference of *timorensis* to *Borsonia*.

*Pleurotoma tjibaliungensis* K. Martin, 1895, Die Foss. von Java, Neue Folge, vol. 1, Gast., Samml. Geol. Reichs-Mus., Leiden, p. 32, pl. 5, figs. 78, 78a. *Surcula*, Vlerk, 1931, Leidsche

Geol. Meded., vol. 5, p. 220. (Java, Tjibaliung, Pliocene). This small shell of about 10 mm. ( $\frac{3}{8}$  inch) in height is biconic fusiform, with rather swollen subangulate whorls, that are simply sculptured with distant prominent axial folds, which extend from the narrowly submargined suture to well over the base, becoming obsolete only over the anterior end. The axials are almost vertical and are most prominent in the vicinity of the subangle; estimated at about 7 per whorl. Dr. L. R. Cox (1948, Schweizer. Palaeont. Abhandl., 66, p. 55) considered this species to belong to *Clavus*. In this we concur.

*Turricula wangwana* Nomura, 1935, Sci. Rep. Tohoku Imper. Univ., Sendai, Japan, ser. 2, Geol., vol. 18 no. 2, p. 115, pl. 6, figs. 37a, b. Taiwan (Formosa), Byoritu Beds, Pliocene. The author of this species remarked that "The strong axial ribs, long aperture and canal are the most characteristic features of this species. No allied forms, recent or fossil, have been reported from the orient, except for *Pleurotoma (Surcula) rembangensis* Martin from the Pliocene of Java". I have not seen *wangwana* but since its author compared the shell with *rembangensis*, it is accordingly, but provisionally listed under "doubtful taxa".

### Acknowledgements

The writer is greatly indebted to Mr. W. B. Dixon Stroud for his continued generous monetary support of the turrid project, and also to the long list of people mentioned in Part 1 of this series, for help and facilities they freely provided. This acknowledgement applies equally well to the present part, as it will also, to parts published subsequently.

To the original list of acknowledgements the writer now records his thanks to the following additional people who have helped materially in many ways. To Dr. H. Lemche of the University Museum, Copenhagen, for the loan of an extensive collection of preserved material, mostly from Indonesian localities; to Dr. H. Steinitz, Department of Zoology, The Hebrew University of Jerusalem for Red Sea material; to Mr. Franz B. Steiner of Tiburon, California, for extensive series of turrids from Indian and South



East Asian localities; to Mr. Donald Dan of Manila for Philippine turrids; to Mr. Bary Scott of Cronulla, New South Wales, for dredged material; to Mr. B. Beutel of Redcliff Peninsula, Queensland, for extensive trawled material; to Dr. J. P. E. Morrison of the United States National Museum, Washington, for permission to use drawings of radulae preparations he had made, and to Mr. S. P. Dance, formerly of the British Museum (Natural History) and now at the National Museum in Wales for photographs of certain types.

Of the first list of acknowledgements, the following people have been very active in regularly forwarding additional material: Mrs. Virginia Maes (nee Orr); Mrs. J. Kerslake, Mr. T. Garrard and Mr. Clifton S. Weaver. To Dr. R. Tucker Abbott the writer is especially indebted for his continued help with requests for references to the literature, and above all for the onerous task involved in seeing this work through the press.

### Selected Bibliography

(Supplementary to the list in volume 1, number 5, pp. 22-672 and 22-673)

- Barnard, K. H. 1958. Contribution to the knowledge of South African Marine Mollusca, Pt. 1, Gastropoda: Prosobranchiata: Toxoglossa. *Ann. South African Mus.*, vol. 44, pp. 73-163.
- Barnard, K. H. 1963. Deep Sea Mollusca from West of Cape Point, South Africa. *Ann. South African Mus.*, vol. 46, pp. 407-453.
- Bartsch, P. 1945. The west Pacific species of the Molluscan Genus *Aforia*. *Journ. Wash. Acad. Sci.*, vol. 55 no. 12, pp. 388-393.
- Cossmann, M. & Pissarro, G. 1909. The Mollusca of the Ranikot Series, Pt. 1. *Pal. Indica (new ser.)*, vol. 3, pt. 1, no. 1, pp. 1-83.
- MacNeil, F. S. 1960. Tertiary and Quarternary Gastropoda of Okinawa. *U. S. Geol. Surv. Prof. Paper* 339, pp. 1-148.
- Martin, K. 1884. Tiefbohrungen auf Java. *Samml. Geol. Reichs-Mus., Leiden (ser. 1)*, vol. 3, pp. 43-184.
- Martin, K. 1895. Die Fossilien von Java, Bd. 1, Gastropoda. *Samml. Geol. Reichs-Mus., Leiden*, pp. 1-132.
- Martin, K. 1914. Die Fauna des Obereocäns von Nanggulan auf Java. *Samml. Geol. Reichs-Mus., Leiden*, vol. 2, no. 4, pp. 111-126.
- Martin, K. 1916. Die Altmiocäne Fauna des West-Progoegirges auf Java. *Samml. Geol. Reichs-Mus., Leiden*, vol. 2 no. 6, pp. 223-261.
- Martin, K. 1931. Mollusken aus dem Obereocan von Nanggulan. *Wetens. Meded. Mijnb. Ned.-Indie*, vol. 18, pp. 1-56.
- Oyama, K. 1953. Review of the known species of Japanese Turridae (1). *Venus*, vol. 17 no. 3, pp. 151-160.
- Oyama, K. Review of the known species of Japanese Turridae (2). *Venus*, vol. 18 no. 1, pp. 17-20.
- Oyama, K. 1966. On living Japanese Turridae (1). *Venus*, vol. 25 no. 1, pp. 1-20.
- Powell, A. W. B. 1966. The Molluscan Families Speightiidae and Turridae. An evaluation of the valid taxa, both Recent and fossil, with lists of characteristic species. *Bull. no. 5, Auck. Inst. Mus.*, pp. 1-184.
- Powell, A. W. B. 1967. The Family Turridae in the Indo-Pacific. Pt. 1a. The Subfamily Turrinae concluded. *Indo-Pacific Moll.*, vol. 1, no. 7, pp. 409-444. [looseleaf pp. 23-101 to 23-176].
- Shuto, T. 1961. Conacean Gastropods from the Miyazaki Group, Palaeontological Study of the Miyazaki Group, 9. *Mem. Fac. Sci. Kyushu Univ., ser. D, Geol.* vol. 11 no. 2, pp. 71-150.
- Shuto, T. 1965. Turrid gastropods from the Upper Pleistocene Moeshima Shell Bed. *Mem. Fac. Sci. Kyushu Univ., ser. D, Geol.* vol. 16 no. 2, pp. 143-207.
- Shuto, T. & Ueda, Y. 1963. New Oligocene Turrids from North Kyushu. *Jap. Journ. Geol. & Geogr.*, vol. 34 no. 1, pp. 1-17.
- Smith, E. H. 1967a. The Proboscis and Oesophagus of Some British Turrids. *Trans. Roy. Soc. Edinb.*, vol. 67 no. 1, pp. 1-22.
- Smith, E. H. 1967b. The Neogastropod Stomach, with Notes on the Digestive Diverticula and Intestine. *Trans. Roy. Soc. Edinb.* vol. 67 no. 2, pp. 23-42.
- Smith, E. H. 1967c. The Reproductive System of the British Turridae (Gastropoda: Toxoglossa). *Veliger*, vol. 10 no. 2, pp. 176-187.
- Tesch, P. 1915. Jungtertiäre und Quartäre Mollusken von Timor. *Palaont. von Timor*, vol. 9, pp. 23-36.
- Vredenburg, E. 1921. Comparative Diagnoses of Pleurotomidae from the Tertiary Formations of Burma. *Rec. Geol. Surv. India*, vol. 53 no. 2, pp. 83-129.

## Subfamily Turriculinae Powell, 1942

Key to the more characteristic genera of the Turriculinae  
occurring in the Indo-Pacific Region

- A. Shell fusiform, tall-spined, long unnotched anterior canal
- a. Sinus U-shaped, moderately deep, on lower part of shoulder slope
- Whorls slowly increasing
- Axials usually absent from shoulder slope
- Operculum, medio-lateral nucleus
- Sculpture axial and spiral ..... *Turricula*
- Operculum, terminal nucleus
- Sculpture predominantly axial ..... *Comitas*
- Sculpture predominantly spiral .... *Nihouia*
- Axials continued over shoulder slope .. *Pleurofusua*
- Whorls very rapidly increasing
- Protoconch paucispiral
- Shoulder slope slightly sunken ..... *Apiotoua*
- Protoconch polygyrate
- Shoulder slope not sunken ..... *Zemacies*
- b. Sinus wide and deep, occupying whole shoulder slope
- Peripheral angle median or submedian .. *Leucosyrinx*
- Peripheral angle at lower suture ..... *Sibogasyrinx*
- B. Shell tall-spined but short unnotched anterior canal
- Spire turreted, periphery near lower suture
- Sinus moderate U-shaped, on middle shoulder slope
- Operculum with medio-lateral nucleus *Makiyamaia*
- Spire straight-sided, peripheral angle obsolete
- Sinus moderate, sutural; operculum absent *Typhlosyrinx*
- Sinus almost obsolete ..... *Belaturricula*
- C. Shell biconic, tabulated spire, short unnotched anterior canal
- Operculum with terminal nucleus, slightly incoiled ..... *Marshalleua*
- D. Shell with broadly conical spire and long tapered anterior canal ..... *Clavosurcula*
- E. Shell buccinoid, body-whorl capacious, anterior canal short, notched, with fasciole ..... *Austrotoua*
- F. Shell claviform, tall narrow spire, truncated body-whorl with short notched anterior canal. Sinus on shoulder slope, moderate U-shaped.
- Operculum with medio-lateral nucleus ..... *Paradrillia*
- Operculum with terminal nucleus ..... *Vexitomina*

*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*



## Genus *Turricula* Schumacher, 1817

Type: *Turricula tornata* (Dillwyn, 1817)

A genus of large-sized shells of up to 85 mm. (3½ inches) in height, of fusiform shape with a tall spire and a long straight or slightly flexed anterior canal. The shells closely resemble *Turris* in shape and form except for the posterior sinus which is on the shoulder slope, not the peripheral carina or a minor rib immediately above it, as is the case in *Turris*.

The turriculid sinus is moderate to deep with a broadly to narrowly rounded apical termination; narrowly rounded where the sinus is restricted by a heavy subsutural fold. The lower edge of the sinus is confluent with a forwardly projecting extension of the outer lip, which results in a sigmoid profile.

The sculptural features of *Turricula* vary from almost smooth to strong spirals which are usually rendered gemmate to nodulose by axials, the strongest development being peripheral. In the apparently closely allied *Comitas*, the axials are usually long and fold-like and the spirals weak to obsolete.

The protoconch in *Turricula* is small, erect, broadly conical of from 2 to 2½ smooth whorls. The operculum is ovate, pointed top and bottom and with a medio-lateral nucleus; that of *Comitas* is leaf-shaped with a terminal nucleus.

The radula is the "wish-bone" type except that the marginals are in two pieces, the lower part of one limb separated from the rest of the tooth but combined they form a "wish-bone" tooth similar to those of *Turris* and *Gemmula*. In both *fulminata* and *catena* there is a vestigial trace of a central tooth, showing in the case of the latter species a minute single cusp.

The distribution of *Turricula* is with certainly almost the entire tropical Indian Ocean, the Asiatic coastline to southern China and northern Australia. Fossil species go back to the Eocene of Pakistan and there are many later species from the Tertiary of Indonesia and southeast Asia. It is also likely that certain West African Recent species and many Tertiary species from European and American horizons belong here also.

In contrast to the deeper and cooler water *Comitas*, the genus *Turricula*, in the main, favours shallow-water warm seas.

## Synonymy—

- 1817 *Turricula* Schumacher, Essai d'un Nouv. Syst., p. 217.  
Type by monotype: *Turricula flammea* Schumacher, 1817: based upon *Murex javanus* Chemnitz (non Linnaeus, 1767) (= *Murex tornatus* Dillwyn, 1817), Neues Syst. Conchyl. Cab., vol. 4, p. 172, pl. 143, figs. 1336-1338.
- 1853 *Surcula* H. & A. Adams, Genera of Recent Mollusca, vol. 1, p. 88; nom. nov. for *Turricula* Schumacher. 1817 (non Klein who is pre-Linnaean and thus unavailable). Type by subsequent designation, Cossman, 1896, p. 69: *Murex javanus* Linnaeus, 1767.
- 1875 *Surgula* Weinkauff, 1875, Martini-Chemnitz, Syst. Conch. Cab., ed. 2, vol. 4, pt. 3, p. 39 (probably merely a transliteration).

## The *Turricula tornata* Group

The compact *tornata* group of *Turricula* consists of the type *tornata* and its two subspecies *fulminata* and *atjehensis*; *catena*; and the closely related *navarchus* and *profundorum*. The type

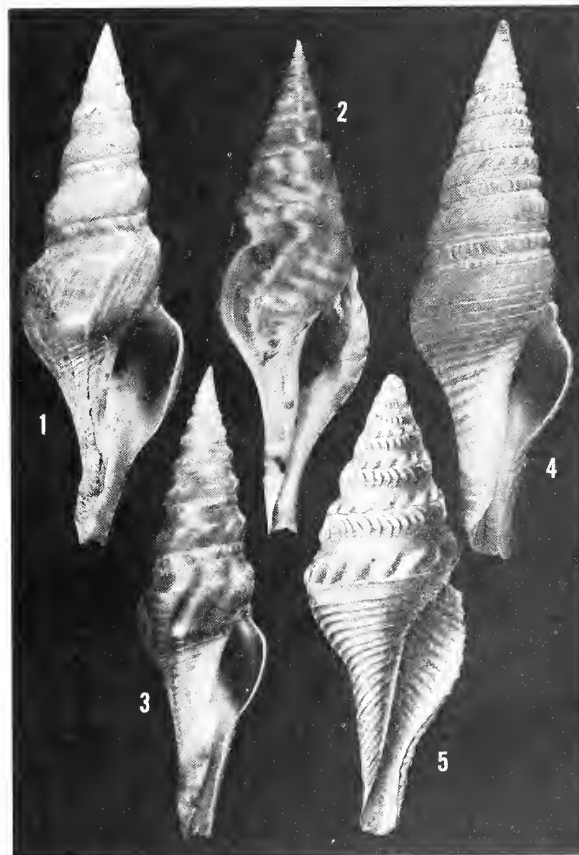


Plate 193. Fig. 1, *Turricula tornata tornata* (Dillwyn), India probably, 85.5 mm. Fig. 2, *Turricula tornata fulminata* (Kien-er), dredged Persian Gulf, 65.5 mm. Fig. 3, *Turricula catena* (Reeve), Gulf of Oman, 20-40 fathoms. 66.5 mm. Fig. 4, *Turricula navarchus* (Melvill & Standen), Persian Gulf, between Charbar and Jask, 200 fathoms. 73.0 mm. Fig. 5, *Turricula profundorum* (E. A. Smith), off Maldive Islands, 719 fathoms (from Annandale & Stewart, 1909, Illust. Zool. Investigator, pt. 6, pl. 7, fig. 2). 34.0 mm.

species, *tornata*, is a large, smooth shell with spiral lirations only on the lower half of the base; the subsutural fold is weak and the colour pattern flammulate in light reddish brown upon an ivory-white ground, but the colour pattern for the most part is obsolete.

In *fulminata* both shape and sculpture are similar to those features in *tornata*, except that the subsutural fold is prominent and the colour pattern strong, in reddish brown upon an ivory-white ground. The distinction between *fulminata* and *tornata*, however, is not more than subspecific value. Their respective geographical patterns, however, are not entirely coincidental, except in the Indian area, for *tornata* extends eastwards to Thailand and *fulminata* westward to the headwaters of the Persian Gulf.

In *catena* the shell is more slender, the colour pattern is strong and similar to that of *fulminata* but the spire whorls are nodulose both on the strong subsutural fold and also at the periphery. This species stands midway between *fulminata* and *navarchus*.

In *navarchus* all whorls are deeply spirally incised, the strong subsutural fold is nodulose but the closely spaced oblique peripheral nodes are restricted to the upper spire-whorls. The colour pattern is weakly flammulate but interrupted by the spiral grooves, which cause a tessellated effect.

Finally, the closely related *profundorum* differs from *navarchus* mainly in the strongly developed but relatively sparse peripheral nodes.

#### *Turricula tornata subspecies*

##### *tornata* (Dillwyn, 1817)

(Pl. 192, figs. 1-3 pt. 193, fig. 1)

*Range*—India to Thailand.

*Remarks*—This large attractive shell, uncommon in collections, is easily recognised by its fusiform shape, rounded whorls, and smooth surface, except for weak spiral lirations on the lower half of the base. The colouration is either plain ivory-white or with the addition of light reddish brown axial flames and maculations.

Dillwyn's *Murex tornatus* probably has priority over Schumacher's *Turricula flammea*. Both are in publications that appeared in 1817, but Dillwyn's work is dated January 1st and Schumacher's March 1st.

*Description*—Shell large, 75 to 85 mm. (3 to 3½ inches) in height, fusiform, with tall spire (32-33°) and a long slightly twisted and recurved anterior canal. Spire height equal to that of the

aperture plus canal. Adult whorls 11-12, exclusive of the protoconch which is missing in all the material examined. Axial sculpture is confined to the early post-embryonic whorls and is in the form of subobsolete subsutural and oblique peripheral nodules. The surface is smooth and polished, except for overall dense microscopic spiral striae and strongly incised, closely spaced spiral grooves, which are confined to the lower part of the base, neck and anterior fasciole. The spire is turreted by a deeply concave shoulder between a broad but weak subsutural fold and the lower extremity of the shoulder, which is just above middle whorl height and is slightly less than the maximum diameter of the whorls. Sinus occupying most of the shoulder sigmoid, suddenly and deeply cut in at the sutural submargin, narrowly rounded at its apex, then produced forward and downwards in a wide protractive arc. Colour usually plain ivory-white but some examples have an overlaid pattern in light reddish-brown. The pattern has resolved from coalescent retractive axial flames. Operculum clavatulid, ovate but angulate top and bottom, with the nucleus just below centre within the inner margin.

#### *Measurements (mm.)—*

height	width	
85.5	27.0	locality ? (Powell coll., Auck. Mus.)
83.0	27.5	Madras (Brit. Mus.)
70.8	22.5	Off Burma (ANSP)
66.5	21.0	Madras (Brit. Mus.)

#### *Synonymy—*

- 1791 *Murex javanus* (Chemnitz) Gmelin, Syst. Naturae, vol. 1, no. 6, p. 3541 (based upon Conch. Cab., vol. 4, pl. 143, figs. 1336-1338) (non *Murex javanus* Linnaeus, 1767)
- 1798 *Turris javana* (Chemnitz) Röding, Museum Boltenianum, vol. 2, p. 124, sp. 1592 (based upon Conch. Cab., vol. 4, pl. 143, figs. 1337, 1338).
- 1807 *Pleurotoma javana* (Chemnitz) Link, Beschreibung der Natural-Samml. der Univ. zu Rostock, p. 119 (based upon Conch. Cab. vol. 4, pl. 143, figs. 1336-1338).
- 1817 *Turricula flammea* Schumacher, Essai Vers test., p. 218 (based upon Conch. Cab. vol. 4, pl. 143, figs. 1336-1338).
- 1817 *Murex tornatus* (Chemnitz), Dillwyn, Descriptive Cat. Recent Shells, vol. 2, p. 715 (based upon Conch. Cab. vol. 4, pl. 143, figs. 1336-1338).
- 1839-40 *Pleurotoma javana* (Roissy) Kiener, Icon. Coq. Viv. Pleurotome, p. 20, pl. 5, fig. 4.
- 1843 *Pleurotoma javana* (Chemnitz) Reeve, Conch. Iconica, vol. 1, pl. 4, sp. 26.
- 1884 *Surcula tornata* (Dillwyn), Tryon, Manual of Conch., vol. 6, p. 237, pl. 5, fig. 62 (not pl. 6, fig. 81 = *fulminata* Kiener).
- 1932 *Turricula flammea* Schumacher, Grant & Gale, Plioc. & Pleist. Moll. of Calif., Mem. San Diego Soc. Nat. Hist., vol. 1, p. 486, pl. 25, figs. 9a, 9b.

*Records*—CEYLON (Grant & Gale, 1931, p. 486). INDIA: Calaba, Bombay (USNM). Madras (Winckworth coll., Brit. Mus.). THAILAND: Ko Phuket, west coast (J. Q. Burch). BURMA: 31 metres, 70 mi. west of Heinze Chaung (Anton Bruun Sta. 39a, 1963, ANSP); 22 metres, gray mud, 35 mi. S. E. of Irrawaddy River outlet (Anton Bruun Sta. 41a, 1963, R. T. Abbott, ANSP).

***Turricula tornata subspecies  
fulminata* (Kiener, 1839-40)**  
(Pl. 192, fig. 4, 5; pl. 193, fig. 2)

*Range*—Persian Gulf and the Arabian Sea to the west coast of southern India, 5-27 fathoms. The centre of distribution appears to be the Persian Gulf.

*Remarks*—This subspecies is very similar to the maculated form of the typical species but can always be distinguished by the heavier sub-sutural fold and the stronger, more clear-cut colour pattern of retractive reddish brown flames.

*Description*—Shell large, 58-70 mm. (2-3 inches) in height. Spire much less than height of aperture plus canal; 33-34°. Whorls 10, plus a small smooth papillate protoconch of 1½ whorls, the axis oblique. Subsutural fold broad and relatively strong, the shoulder concavity slight and ill defined at its lower extremity. Colour pattern of reddish-brown, strongly retractive narrow flames on an ivory-white ground. The flames coalesce above to form irregular blotches over the shoulder area. Other characters are as in the typical species. Operculum (pp. 189, fig. 6). Radula (pp. 191, fig. 5).

Melville's subspecies *gloriosa* is dismissed as a variant with an abnormally short spire.

**Synonymy—**

- 1839-40 *Pleurotoma fulminata* Kiener, Coquilles Vivantes, vol. 5, Pleurotome, p. 21, pl. 10, fig. 2 (l'Océan Indien).  
1843 *Pleurotoma fulminata* (Kiener), Reeve, Conch. Iconica, vol. 1, pl. 5, fig. 37.  
1884 *Surcula tornata fulminata* (Kiener), Tryon, Man. of Conch., vol. 6, p. 237, pl. 6, fig. 81.  
1917 *Surcula fulminata* (Kiener), Melville, Proc. Malac. Soc., London, vol. 12, p. 163.  
1917 *Surcula fulminata gloriosa* Melville, Proc. Malac. Soc., London, vol. 12, p. 163, pl. 8, fig. 11.  
1956 *Turricula fulminata* (Kiener), Kaicher, Indo-Pacific Sea Shells, Toxoglossa, pl. 1, fig. 10.

**Measurements (mm.)—**

height	width	
69.5	22.0	
65.5	20.0	all Kuh-i-Mubarik, Gulf of Oman
62.0	19.0	
61.5	19.5	
58.5	18.0	

*Records*—PERSIAN GULF: Mussandam, 27 fathoms; Basadu (type of *gloriosa*). GULF OF OMAN: Muscat, 5-10 fathoms (Melville, 1917); Kuh-i-Mubarik, 25 miles west of Jask (Townsend coll., Brit. Mus.). INDIA: Back Bay, Bombay and Karwar, N. Kanara (J. C. Bridwell, USNM); Bombay Harbour to Goa (Melville, 1917). PAKISTAN: Karachi (USNM).

***Turricula tornata subspecies  
atjehensis* (Oostingh, 1938)**  
(Pl. 195, figs. 1-3)

*Range*—Pliocene of Sumatra and Java, Indonesia.

*Remarks*—This subspecies differs from the Recent typical species in having both the axial and the spiral sculpture much stronger. There is a prominent subsutural fold, which is crenulated,

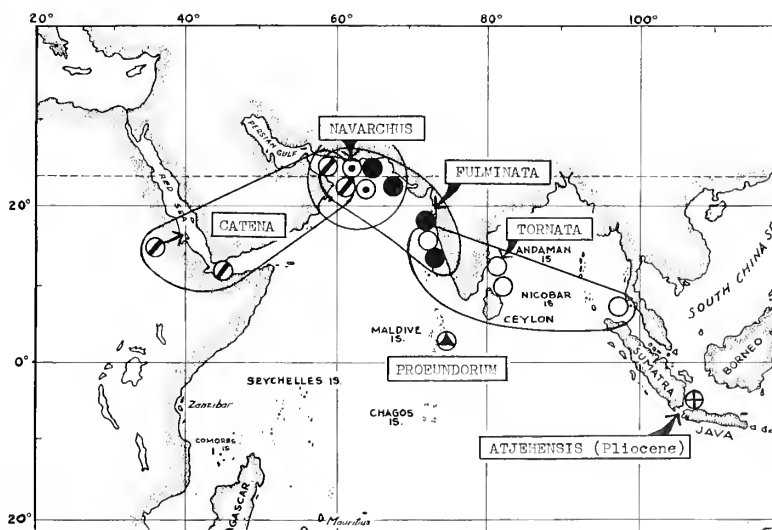


Plate 194. Geographical distribution of *Turricula tornata* (Dillwyn) and subspecies *fulminata* (Kiener), *Turricula navarchus* (Melville & Standen), *T. catena* (Reeve), *T. pro-*

*fundorum* (E. A. Smith) and the Pliocene *T. tornata atjehensis* Oostingh.



and the short, very oblique peripheral axials are not only strong on the spire-whorls but persist over most of the body-whorl. In the typical species the subsutural fold is weak and the axials are confined to the early post-nuclear whorls.

*Measurements (mm.)—*

height	width
65.0	20.5

*Synonymy—*

1938 *Turricula (Turricula) flammea atjehensis* Oostingh, Paleo. Dienst. Mijnb. Bandoeng, Java, Gast., pt. 1, p. 24, pl. 1, figs. 10-16. (North Atjeh and South Bantam).

*Turricula catena* (Reeve, 1843)

(Pl. 193, fig. 3, pl. 192, figs. 6, 7)

*Range*—Red Sea and Persian Gulf to Aden, 20 to 40 fathoms.

*Remarks*—This species has a similar colour pattern to that of *tornata fulminata* but the shell is conspicuously narrower and has well developed nodulose sculpture over the spire-whorls, that on the subsutural band being prominent throughout. The protoconch differs from that of *tornata fulminata* in being broadly conical, of one more whorl, and with the axis erect, not oblique.

*Description*—Shell large, 60-71 mm. (2¼-2¾ inches) in height, narrowly fusiform, with tall spire of about 28 degrees, and a long, stout, rather straight anterior canal, slightly recurved at the tip. Spire whorls 12 plus a small erect broadly conical protoconch of 2½ smooth whorls. Spire-whorls with a broadly rounded subsutural fold and a heavy, bluntly rounded, subperipheral carina, separated by a relatively narrow and deep

shoulder recess. An alternation of strong spiral cords and threads cover the lower base, neck and anterior fasciole. Numerous, narrow, erect axials cross the subsutural fold and appear again as protractively oblique folds over the peripheral carina, but are obsolete elsewhere on the shell. The entire surface is smooth and polished except for dense microscopic striae and a few weak incised lines over the subsutural fold and the shoulder concavity. The subsutural axials persist throughout, but those at the periphery become subobsolete to obsolete over the last 1½ whorls. Sinus as in *tornata* but with its apex not so deep and not so strongly protractively arcuate below; this resultant from the narrower proportions of the shell. Colour pattern of diffused protractive and retractive axial flames in reddish brown upon an ivory-white ground. The general effect is of large irregular blotches of colour. Operculum clavatulid, ovate, with a medio-lateral nucleus, as in *tornata*. The radula is figured on Pl. 191, fig. 4.

*Measurements (mm.)—*

height	width	
71.0	—	Muscat (Melvill, 1917)
66.5	17.5	Muscat, 40 fathoms
63.0	16.5	" " "
62.0	16.5	" " "
61.5	16.5	" " "

*Synonymy—*

1843 *Pleurotoma catena* Reeve, Conch, Iconica, vol. 1, pl. 5, fig. 36 (no locality).

1891 *Pleurotoma (Surcula) catena* (Reeve), Smith. Proc. Zool. Soc. London, p. 403.

1917 *Surcula catena* (Reeve), Melvill, Proc. Malac. Soc. London, vol. 12, p. 162.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—PERSIAN GULF: Gulf of Oman, Muscat, 20-40 fathoms (Townsend coll. Brit. Mus.); Mekran Coast, Charbar (Melvill, 1917) ADEN (E. A. Smith, 1891), RED SEA: Mas-sawa Channel (Dept. Zool. Hebrew Univ., Jerusalem).

*Turricula navarchus* (Melvill & Standen, 1903)

(Pl. 193, fig. 4; pl. 192, figs. 8, 9)

*Range*—Persian Gulf and vicinity, 90 to 200 fathoms.

*Remarks*—This species may be considered to be a bathymetric derivation from the shallower water *catena*. It is characterized by a much stronger sculptural development. The spiral incised lines extend over all the adult whorls. The subsutural fold is massive and densely crenulated, and the shoulder concavity bears a single, strong, smooth spiral cord.

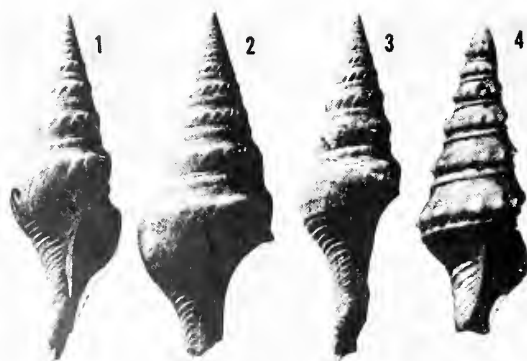


Plate 195. Figs. 1-3, *Turricula tornata* subspecies *atjehensis* Oostingh. Pliocene of South Bantam, Java. 65.0 mm. (from Oostingh, 1938, Pal. Dienst. Mijnb. Bandoeng, Java, Gast. 1, pl. 1, figs. 10-12). Fig. 4, *Turricula terae* Oostingh. Pliocene of South Bantam, Java. 26.5 mm. (from Oostingh, 1938, pl. 1, fig. 19).

*Description*—Shell large, 60-73 mm. (2½-3 inches) in height, very solid, narrowly fusiform, with tall spire and relatively long, straight, stout anterior canal, slightly reflexed at its extremity. Spire slightly taller than height of aperture plus canal. Whorls 11, plus a small, erect, broadly conical protoconch of 2½ smooth whorls. Spire-whorls with a massive broadly rounded sub-sutural fold densely sculptured with cog-like axials. Shoulder concavity narrow and deep, with a median-placed, strong, smooth spiral cord. Peripheral carina at about middle whorl height, broadly rounded, strong on the early whorls and crossed by protractively oblique axial folds. The peripheral carina and its sculpture both become subobsolete over the last two whorls, but the subsutural fold remains strong throughout. The entire surface below the peripheral carina is deeply incised, forming flat-topped broad spirals, three below the periphery on the spire and 6 or 7 on the upper base. Below these the spirals change in character to strong narrow crested cords with interspaces of a width rather greater than that of the cords. About 8 or 9 of these cords are present over the neck. Below are weaker indistinct irregular spirals on the anterior fasciole. Colour pattern of very diffused and indistinct reddish brown axial flames on a pale yellowish brown ground. Owing to the incised surface the colour flames appear as an irregular tessellation of the flat-topped spirals and the cords of the base and neck. Sinus and operculum both identical with those of *catena*.

*Measurements (mm.)—*

height	width	
73.0	21.5	between Charbar and Jask, 200 fathoms
64.0	18.0	Gulf of Oman, 140 fathoms (holotype)
55.0	17.5	between Charbar and Jask, 200 fathoms

*Synonymy—*

- 1903 *Pleurotoma (Gemmula) navarchus* Melvill & Standen, Ann. & Mag. Nat. Hist., ser. 7, vol. 12, p. 310, pl. 21, fig. 15.  
 1906 *Clavatula navarchus* (Melvill & Standen), Smith, Ann. & Mag. Nat. Hist., ser. 7, vol. 18, p. 160.  
 1917 *Clavatula navarchus* (Melvill & Standen), Melvill, Proc. Malac. Soc., London, vol. 12, p. 165.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—PERSIAN GULF: Gulf of Oman, 25° 19' N., 58° 10' E., 140 fathoms (type locality); off Mekran Coast, between Charbar and Jask, 200 fathoms (Townsend coll., Brit. Mus.).

**Turricula profundorum (E. A. Smith, 1896)**

(Pl. 193, fig. 5)

*Range*—Deep water, off the Maldive Islands, Indian Ocean.

*Remarks*—This species is known only from the type specimen in the Indian Museum, but the excellent figures of Annandale and Stewart (see synonymy) leave no doubt of the relationship of the species with *navarchus*. The chief differences from that species would appear to be the adpressed suture, which impinges upon the peripheral carina, the wide smooth shoulder concavity, the strong relatively sparse development of the protractively oblique peripheral nodules, the raised cords rather than incised spiral grooves of the base, and the conspicuous spiral fluting within the outer lip. An example of *navarchus* of comparable size with the type of *profundorum* was used for the above comparison.

*Measurements (mm.)—*

height	width	
34.0	12.0	holotype

*Synonymy—*

- 1896 *Pleurotoma (Surcula) profundorum* E. A. Smith, Ann. & Mag. Nat. Hist., ser. 6, vol. 18, p. 369.  
 1909 *Pleurotoma (Surcula) profundorum* (E. A. Smith), Annandale & Stewart, Illustrations, Zoology of Roy. Indian Mar. Surv. Ship "Investigator", Mollusca, part 6, pl. 7, figs. 2, 2a.

*Types*—Holotype (unique) is in the Indian Museum, Calcutta.

*Records*—MALDIVE ISLANDS: 719 fathoms (type locality).

**Turricula javana (Linnaeus, 1767)**

(Pl. 192, figs. 10, 11; pl. 201, fig. 1)

*Range*—A verified range of from southwest India to southern China, but recorded also from Karachi, Dar-es-Salaam and Somali Coast in 863 metres. Also recorded from the upper Tertiary of Java, Nias, Sumatra, Timor and southern India.

*Remarks*—This common shallow water, moderately large shell of the East is easily recognized by its strongly and obliquely nodulose peripheral angle and light brown to purplish brown uniform colour.

Although *Surcula* H. & A. Adams, 1853, based upon this species has often been used both generically and subgenerically as distinct from

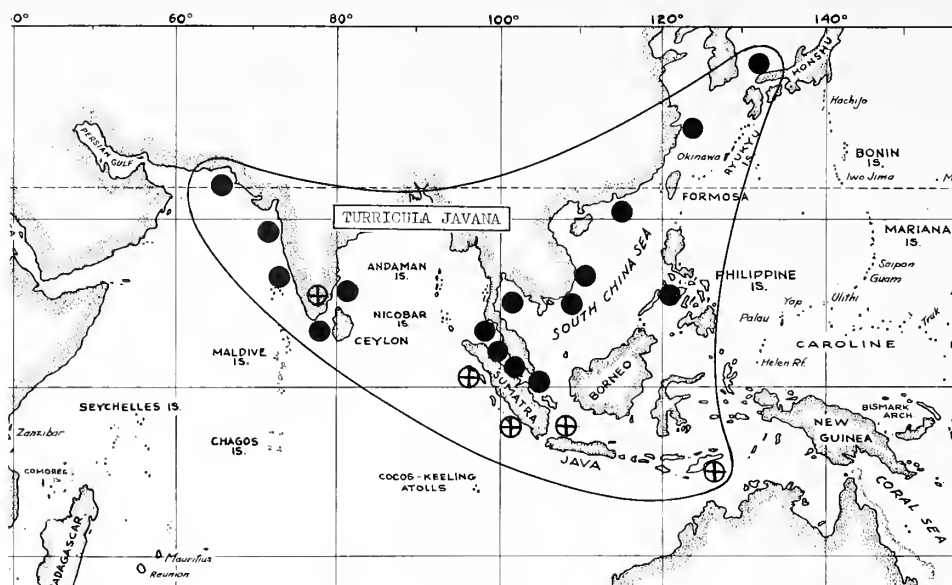


Plate 196. Geographical distribution of *Turricula javana* (Linnaeus). Tertiary occurrences are indicated by a cross within a circle.

*Turricula*, there is no justification for such action. The essential features of both the protoconch and the operculum are identical for both nominate groups.

**Description**—Shell large, 60-76 mm. (2½-3 inches) in height, fusiform-biconic, with tall turretted spire, 35-40°, and moderately long flexuous anterior canal. Spire equal to or slightly greater than height of aperture plus canal. All post-nuclear whorls strongly nodose carinate. Whorls 10-11 plus a very small narrowly conic smooth protoconch of about two whorls (pl. 211, fig. 1). Adult sculpture of numerous closely-spaced spiral cords crossed on the peripheral carina only, by numerous strong, short protractively oblique nodules, 22-17 on the last two whorls. Spire-whorls with a subsutural collar of two strong cords, followed by a wide steeply descending lightly concave shoulder area to the peripheral carina which is situated below the middle whorl height. Shoulder area bearing 6-9 fine spiral threads; the carina, and below it to the suture with stronger spiral cords and occasional intermediate threads; 3-5 primary cords between the carina and the lower suture. Body-whorl with 22-26 primary cords between the carina and the end of the anterior canal, plus 0-3 threads in each interspace. Sinus deeply cut in, below and parallel to the lower edge of the subsutural margin, apex broadly rounded, extended

forwards parallel with the upper edge and then produced into the broadly rounded protractive arc of the outer lip. Operculum ovate, pointed top and bottom, with a medio-lateral nucleus (pl. 189, fig. 5). Colour ranging from creamy-buff to dull purplish brown, the peripheral nodules paler. Shallow water shells are generally darker in colour, especially within the aperture.

#### Measurements (mm.)—

height	width	
76.5	23.5	Malacca
70.5	25.0	Tanjong Katong, Malaya
70.0	26.0	Bombay
63.0	23.5	Madras
61.0	24.0	Bombay

#### Synonymy—

- 1767 *Murex javanus* Linnaeus, *Systema Naturae Regnum Animale*, 12th. ed., sp. 550, p. 1221; 1957, Dodge, *Bull. Amer. Mus. Nat. Hist.*, vol. 113, p. 147-151.
- 1791 *Murex turris* Gmelin, *Syst. Naturae*, vol. 1 no. 6, p. 3543 (based upon Bonanni, class 3, fig. 79 (Hedley, 1922, *Rec. Aust. Mus.*, vol. 13 no. 6, p. 254).
- 1811 *Pleurotoma contorta* Perry, *Conchology*, London, pl. 32, fig. 1.
- 1822 *Pleurotoma nodifera* Lamarck, *Anim. sans Vert.*, vol. 7, p. 96.
- 1839-40 *Pleurotoma nodifera* Lamarck, Kiener, *Icon. Coq. Viv. Pleurotome*, p. 22, pl. 12, fig. 1 (l'Océan Indien, la côte de Malabar).
- 1843 *Pleurotoma nodifera* Lamarck, Reeve, *Conchologia Iconica*, vol. 1, pl. 4, f. 28 (Straits of Malacca).
- 1884 *Surcula javana* (Linnaeus), Tryon, *Manual of Conch.*, vol. 6, p. 237, pl. 5, fig. 63 (only).
- 1900 *Surcula javana* (Linnaeus), Cossmann, *Journ. de Conch.*, vol. 48, p. 33 (Pliocene of Karikal, India).
- ?1903 *Surcula javana* (Linnaeus), von Martens, *Die beschalten Gastropoden der deutschen Tiefsee-Exped.*, 1898-1899, p. 78 (Dar-es-Salaam and Somali Coast, 863 metres).



- 1917 *Surcula javana* (Linnaeus), Melvill, Proc. Malac. Soc., London, vol. 12, p. 163 (Karachi and Bombay).  
 1931 *Surcula nodifera* (Lamarek), van der Vlerk, Leidsche Geologische Mededeelingen, vol. 5, p. 220 (Up. Miocene, Pliocene and Quaternary of Indonesia).  
 1956 *Turricula javana* (Linnaeus), Kaicher, Indo-Pacific Sea Shells, pl. 1, fig. 9.

*Records*—INDIA: Madras (Winckworth coll., Brit. Mus.); Bombay (Winckworth coll., Brit. Mus. & ANSP); Goa; Bandra, north of Bombay (J. E. Bridwell, USNM). CEYLON: 2 mi. N. of Chilaw Lagoon, west Ceylon; 2-5 mi. N. of Colombo Harbour, 3-7 fathoms, sand and mud (G. & M. Kline, 1957, ANSP). INDONESIA: Malacca (ANSP & Brit. Mus.). MALAYA: muddy shore at Tanjong Katong, near Penang (Winckworth coll. Brit. Mus.); Singapore (ANSP). THAILAND: Ko Phuket, west coast (J. Q. Burch); Singora, Gulf of Siam (USNM); INDOCHINA, Ba-Lang, North Annam (ANSP). CHINA: Hongkong; Yu-Hwen, Chekiang Province (USNM).

*Fossil Records*—Recorded from the upper Miocene, Pliocene and Quaternary of Java, the upper Miocene of Nias and the Pliocene of Karikal, Southern India, Sumatra and Timor (Cossmann, 1900 and van der Vlerk, 1931).

*Turricula javana subspecies  
tegalensis* (K. Martin, 1895)

(Pl. 207, figs. 3, 4)

*Range*—Pliocene? of Pangka, Java.

*Remarks*—It is difficult to decide from the illustrations of this subspecies if it is really distinct from the Recent *javana*. If the Javanese fossil is as constantly distinct as the illustrations imply, then it is characterised by having a simple, not

bicingulate subsutural fold and longer peripheral protractively oblique axials, which reach the lower suture. The axials in the typical species are short oblique nodulose folds, which are confined to the peripheral carina; in *tegalensis* the axials do not appear to be nodulose at the carina, which is angulate but not prominently carinate.

*Synonymy*—

- 1895 *Pleurotoma (Surcula) nodifera* var. *tegalensis* K. Martin, Samml. Geol. Reichs-Mus., Leiden, Bd. 1, p. 28, pl. 4, fig. 70, pl. 5, figs. 71, 71a.

*Turricula nelliae* (E. A. Smith, 1877)

This group includes the shells formerly identified as *Pleurotoma tuberculata* Gray, 1839, but that name is preoccupied by the same combination of Pusch, 1836.

Smith's *Pleurotoma nelliae*, 1877, proposed for a Mauritius shell, was used by Cox (1948, Schweizer. Palaeont. Abhandl., vol. 66, p. 57), both for North Borneo Neogene fossils and also as a substitute name for the Recent southeast Asian records of *tuberculata* Gray.

Unfortunately *nelliae* is known to me only from the unique holotype in the British Museum, but this specimen exhibits features not covered by the considerable range of variation found in "*tuberculata*" populations from the Indo-Asian-China Seas area.

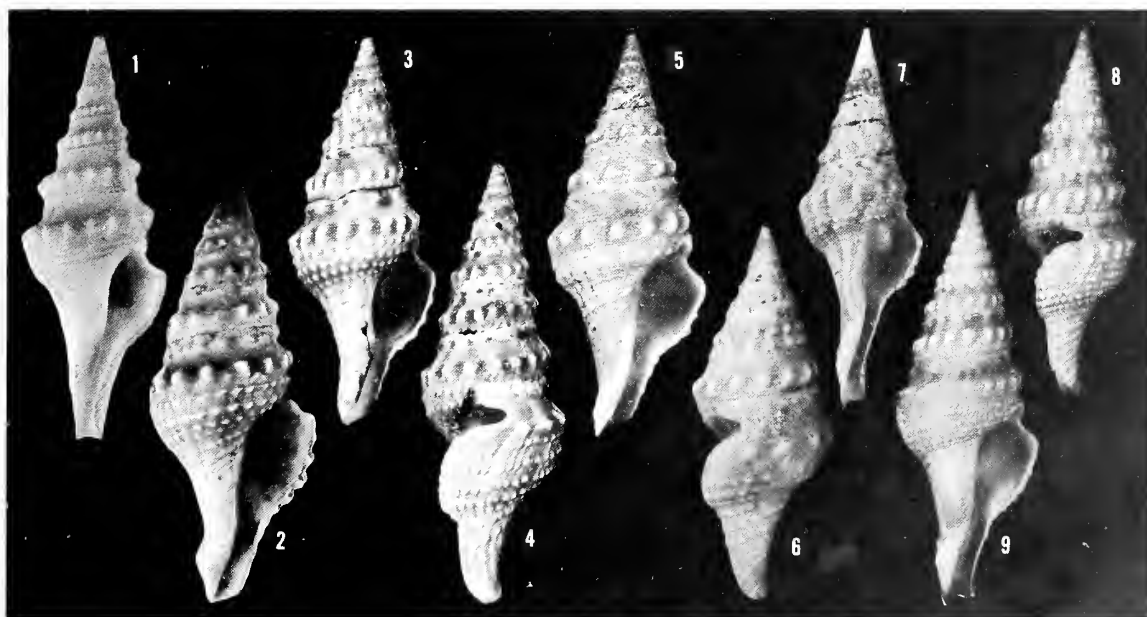


Plate 197. Fig. 1, *Turricula nelliae nelliae* (E. A. Smith), Mauritius, holotype. 30.0 mm. Figs. 2-7, *Turricula nelliae spurius* (Hedley). Fig. 2, holotype of *Pleurotoma tuberculata* Gray. 32.2 mm. Figs. 3, 4, Hong Kong. Figs. 5, 6, Goa India.

Fig. 7, Lampoeng Bay, 29 metres, Sumatra. 34.5 mm. Figs. 8, 9, *Turricula nelliae granobalteus* (Hedley). Broome, N. W. Australia. 30.5 and 34.0 mm.

There is a name available for the preoccupied *tuberculata* Gray in *Inquisitor spurius* Hedley (1922, Rec. Aust. Mus., vol. 13, p. 245), but in the same publication, Hedley (p. 240) described a northern Queensland shell as *Inquisitor granobalteus*, and this is more closely related to *spurius* than it is to *nelliae*.

One further name must be considered, *Surcula setlurama* Vredenburg (1921, Records Geol. Surv. India, vol. 53, p. 88), which was proposed for a Burmese Miocene fossil, considered by its author to be close to the Recent "*tuberculata*".

Excluding *setlurama*, the exact status of which requires investigation with material unavailable to me, the members of this group resolve apparently into the following geographic subspecies: - *nelliae nelliae* (E. A. Smith, 1877) of Mauritius; *nelliae spurius* (Hedley, 1922) of the Persian Gulf, India, Indonesia, West New Guinea, Indo-China, southern China and the Neogene of Borneo; and *nelliae granobalteus* (Hedley, 1922) from Cape York to Broome, northern Australia.

The Mauritius *nelliae* differs from *spurius* in having rather long vertical axials on a prominent broadly rounded peripheral keel, numerous plain basal spirals and a long straight anterior canal.

In *spurius* the peripheral axials are more rounded, slightly oblique tubercles, the basal spirals are relatively sparse and strongly gemmate, and the anterior canal is distinctly flexed.

In *granobalteus* the peripheral axials and the basal spirals are more numerous and the latter are finely gemmate.

#### Key to the *nelliae* subspecies

- A. Anterior canal straight
  - Basal spirals numerous, plain
    - ..... *nelliae nelliae* (E. A. Smith)
- B. Anterior canal flexed
  - Basal spirals numerous, finely gemmate.
    - Peripheral nodes numerous, 18-22 per whorl ..... *nelliae granobalteus* (Hedley)
  - Basal spirals fewer, strongly gemmate
    - Peripheral nodes fewer, 14-17 per whorl
      - ..... *nelliae spurius* (Hedley)

#### *Turricula nelliae* subspecies *nelliae* (E. A. Smith, 1877)

(Pl. 197, figs. 1)

*Range*—Mauritius.

*Remarks*—The typical species is known to me only from the apparently unique holotype. From the subspecies *spurius*, better known under the preoccupied name *tuberculata* Gray, the Mauritius shell is distinguished by its perfectly straight anterior canal, vertical cog-like peripheral axials, weak bicingulate subsutural margining, and non-gemmate subsidiary spiral sculpture. The colour is white, partially diffused with pale lilac.

A detailed description of the holotype is not given since there is no other Mauritius material available to gauge the range of variation, which in the two better known subspecies is quite considerable. A figure of the holotype of *nelliae* is given for comparison with a series of variants in the *spurius* range. The finding of further topotypic material of *nelliae* may even alter the status of *nelliae* to that of a full species.

#### *Measurements* (mm.)—

height	width
30.0	11.0

#### *Synonymy*—

1877 *Pleurotoma nelliae* E. A. Smith, Ann. Mag. Nat. Hist., ser. 4, vol. 19, p. 489 (not figured).

1917 *Surcula nelliae* (Smith), Melvill, Proc. Malac. Soc., vol. 12, p. 164, pl. 8, fig. 2 (in part, fig. of holotype, only)

*Types*—The holotype, apparently unique, is in the British Museum (Natural History).

#### *Turricula nelliae* subspecies *spurius* (Hedley, 1922)

(Pl. 197, figs. 2-7)

*Range*—Persian Gulf to China Seas.

*Remarks*—This subspecies, better known under the preoccupied name of *tuberculata* (Gray), is rather similar to *javana* (Linnaeus). The chief differentiating criteria are:—more or less erect peripheral nodes and tuberculate basal spirals in *spurius*—oblique peripheral nodes and plain basal spirals in *javana*. There is also a considerable size difference between the two, for an adult *javana* can reach twice the height of the largest known *spurius*, but small examples of each of comparable size are often close in appearance.

The subspecies *spurius* is subject to considerable variation geographically, in relation to depth of occurrence and also, presumably, in response to ecological factors.

Intertidal shells tend to be proportionately wider, with a relatively short canal, heavy round-

ed peripheral nodes and strongly tuberculate basal spirals. Dredged shells (9-45 fathoms, Persian Gulf and Sumatra) are slender with a relatively long and only slightly flexed anterior canal. Some shallow-water shells from Chinese waters are broad and robust with distinct tuberculation of the basal spirals but the peripheral nodes tend to be oblique as in *javana*.

*Description* (specimen from China Seas)—Shell 30-35 mm. (1-1 $\frac{1}{3}$  inches) in height, fusiform, with tall spire, 36-37°, and moderately long slightly flexed anterior canal. The spire angle of the type of *tuberculata* is 36° and that of the type of *nelliæ* 34°. Spire slightly taller than height of aperture plus canal. Whorls 11-11 $\frac{1}{2}$ , including a small smooth erect narrowly conic protoconch of 1 $\frac{1}{2}$  whorls. Spire-whorls with a prominent subsutural collar, sharp edged below and bearing one or two spiral threads on its flat surface above, followed by a wide concave shoulder slope, bearing 3-4 fine spiral threads. Peripheral carina prominent, broadly rounded, well below the middle of whorl height and sculptured with 16-19 slightly protractively oblique blunt smooth nodules per whorl, which are longer than wide, the interstices with three spiral threads. Between the peripheral carina and the lower suture are 2-3 smooth spiral threads and the half emergent uppermost of the granulate basal spirals. Base with about 6 granulated primary spirals and a further 4-6 smooth spirals over the neck and

anterior end, 1-2 spiral threads in each interspace. Colour pale yellowish brown, obscurely maculated in pale reddish brown between the nodes and granules. Sinus deep, rather wide, with a broadly rounded apex, occupying the middle of the shoulder concavity and confluent below with the broadly arcuate forwardly projected outer lip. Although *tuberculata* was described from unknown locality, the holotype is labelled "China".

*Description* of a specimen from Goa, India, shallow-water—Shell 30-32 mm. (about 1 $\frac{1}{4}$  inches) in height; 10-10 $\frac{1}{2}$  whorls, robust, with heavy rounded peripheral nodules, 14-15 per whorl; basal spirals strongly gemmate. Spire 32-35°, considerably less than height of aperture plus canal.

*Description* of a specimen from Sumatra, 9-29 metres). Shell 30-35 mm. (1-1 $\frac{1}{3}$  inches) in height; 11-12 whorls, lightly built, with moderately strong peripheral nodules, 14-15 per whorl; upper basal spirals finely gemmate. Spire 32-35°, considerably less than height of aperture plus canal. Operculum ovate to leaf-shaped, with a lateral nucleus situated above the middle, on the inner margin.

#### Measurements (mm.)—

height	width	
35.0	12.0	Yu Hwen, China (USNM)
34.5	11.0	Sumatra, 29 metres
33.5	10.6	Sumatra, 29 metres

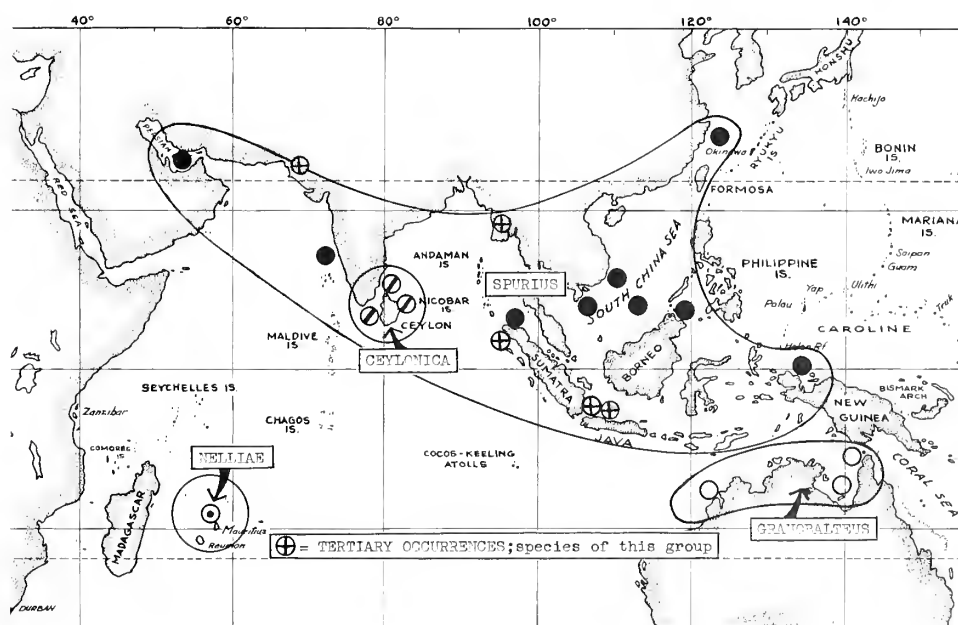


Plate 198. Geographical distribution of *Turricula ceylonica* (E. A. Smith); *T. nelliæ* (E. A. Smith) and subspecies *spurius*

(Hedley); and *granobalteus* (Hedley). Tertiary occurrences of related species are indicated by a cross within a circle.



32.5	12.2	Goa, India (USNM)
32.2	12.0	China (holotype of <i>tuberculata</i> )
32.0	12.5	Goa, India (USNM)
30.0	11.5	China Seas (USNM)

### Synonymy—

- 1839 *Pleurotoma tuberculata* Gray, Zool. Beechey's Voy., p. 120 (non Pusch, 1836). Type locality unknown.  
 1843 *Pleurotoma tuberculata* Gray, Reeve, Conch. Iconica, vol. 1, pl. 9, fig. 72.  
 1845 *Pleurotoma punctata* Reeve, Conch. Iconica, vol. I, pl. 21, fig. 181 (non Schubert & Wagner, 1829)  
 1884 *Surcula tuberculata* (Gray), Tryon, Manual of Conch., vol. 6, p. 237, pl. 5, figs. 66, 67.  
 1917 *Surcula nelliae* (Smith), Melvill, Proc. Malac. Soc., vol. 12 p. 164 (non Smith, 1977, except for figure of holotype)  
 1917 *Surcula tuberculata* (Gray), Melvill, Proc. Malac. Soc., vol. 12, p. 164.  
 1922 *Inquisitor spurius* Hedley, Rec. Aust. Mus., vol. 13 no. 6, p. 245; *nom. nov.* for *Pl. tuberculata* Gray, 1839 (non Pusch, 1836)  
 1925 *Surcula tuberculata* (Gray), Vredenburg, Mem. Geol. Surv. India, vol. 50, p. 35.  
 1928 *Surcula javana* (Linnaeus), Yokoyama, Rep. Imper. Geol. Surv. Japan, vol. 101, p. 33, pl. 1, fig. 12 (non Linnaeus, 1767)  
 1935 *Turricula byoritensis* Nomura, Sci. Rep. Tohoku Imper. Univ. Sendai, Japan, ser. 2, Geol. vol. 18 no. 2, p. 114, pl. 6, fig. 28a, b.  
 1942 *Brachytoma spuria* (Hedley), Yen, Proc. Mal. Soc. London, vol. 24, p. 239, pl. 25, fig. 182 (holotype of *Pleurotoma tuberculata* Gray, 1839).  
 1948 *Turricula nelliae* (Smith), Cox, Schweizer. Palaeont. Abhandl., vol. 66, p. 57 (non Smith, 1877).

*Types*—The holotype of *tuberculata* Gray is in the British Museum (Natural History), reg. no. 41.4.6.64.

*Records*—CHINA: China Sea; Hong Kong, 4-10 fathoms; Foochow and Yu Hwen, Chekiang Province (USNM); off Lama Islands, 20 fathoms. INDOCHINA: Baie d'Along, Tonkin (AWBP. coll.). WEST NEW GUINEA: 1¼ mi. S.W. of Mantoewoeri Point, Koeroedoi Island, Geelvink Bay, 4 fathoms (NSF, ANSP). BORNEO: off Sandakan Light, 39 fathoms, mud (Albatross Sta. 5358, USNM). SUMATRA: Lampoeng Bay, 5° 42'S., 105° 17'E., 29 metres, mud (Zool. Mus., Copenhagen). INDIA: Goa (USNM). PERSIAN GULF: Henjam, 8-15 fathoms. GULF OF OMAN: Mussandam, 50 fathoms; Kuh-i-Mubarik, 45 fathoms (Townsend coll., Brit. Mus.); 4 mi. S.W. of Suzeh, 9-11 metres (Zool. Mus., Copenhagen).

### *Turricula nelliae* subspecies

#### *granobalteus* (Hedley, 1922)

(Pl. 197, figs. 8, 9)

*Range*—Cape York to Broome, northern Australia.

*Description*—Shell 26-34 mm. (1-1⅜ inches) in height, fusiform, with tall spire, 32-34°, and with a moderately long, slightly flexed, anterior canal. Spire about equal to or slightly greater than height of aperture plus canal. Whorls 14-14½, including a small, smooth, erect, narrowly conic protoconch of 1½ whorls. Sculpture: suture submargined by a strong fold consisting of

two linear spaced spiral cords, followed by a deeply concave shoulder area, bearing 3-5 finely granulated spiral threads. Then a prominent blunt flange-like peripheral keel, bearing strong tubercles, 18-22 per whorl, and these are longer than broad. About 20 primary spirals on the base, all finely and closely granulated, and one, sometimes two, plain spiral threads in each interspace. Sinus deep, U-shaped, restricted by the prominent subsutural fold. Colour buff, with rust-red dots between the peripheral nodes and paler irregular streaks and splashes elsewhere.

### *Measurements* (mm.)—

height	width	
34.0	12.0	Broome
30.5	10.5	Broome
26.0	9.0	holotype

### Synonymy—

- 1922 *Inquisitor granobalteus* Hedley, Rec. Aust. Mus., vol. 13, no. 6, p. 240, pl. 44, fig. 30.

*Types*—The holotype is in the Australian Museum, Sydney.  
*Records*—QUEENSLAND: Karumba, mouth of Norman River (type locality); Forsyth Island and Mapoon, Gulf of Carpentaria; Cape York, 11 fathoms (Australian Mus.). NORTH WEST AUSTRALIA: Broome (Auck. Mus.); Roebuck Bay (Nat. Mus. Victoria).

### *Turricula sethuramae* (Vredenburg, 1921)

(Pl. 199, figs. 2, 3)

*Range*—Dalabe, Kama Stage of the Aquitanian Miocene, Burma.

*Remarks*—This species appears to be very close to the Recent *spurius* (Hedley); in fact, it may prove to be only a dwarf form of that species, but I do not have access to the relevant material to evaluate Vredenburg's shell.

Vredenburg's very inadequate description of his species is as follows:— "This beautiful shell is related to *Surcula tuberculata* Gray from which it is distinguished by its small size and in the crowded uniform or sub-uniform minute spiral decoration." The measurements below are estimated from the original figures.

### *Measurements* (mm.)—

height	width
13.25	5.0

### Synonymy—

- 1921 *Surcula sethuramae* Vredenburg, Records Geol. Surv. India, vol. 53 no. 2, p. 88, pl. 12, fig. 3.

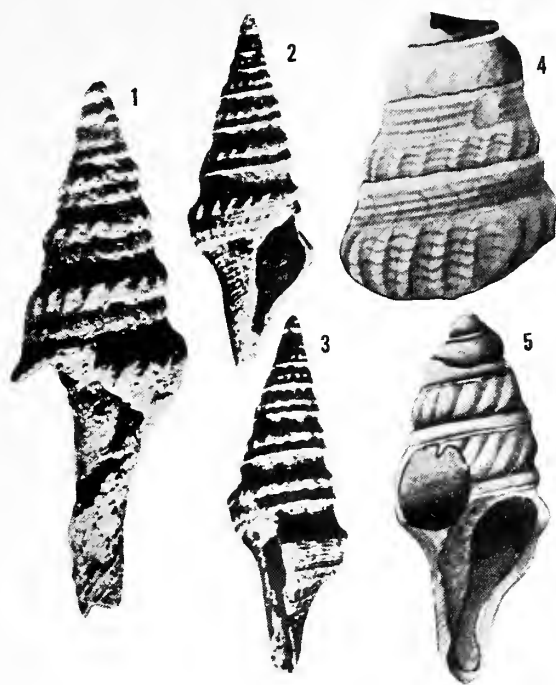


Plate 199. Fig. 1, *Turricula thangaensis* (Vredenburg). Burma, Thanga, Kama Stage, Aquitanian Miocene. 21.0 mm. Figs. 2, 3, *Turricula sethuramiae* (Vredenburg). Burma, Dalabe, Kama Stage, Aquitanian Miocene. 13.3 mm. (from Vredenburg, 1921, Rec. Geol. Surv. India, vol. 53 (2), pl. 12, figs. 5, 3.). Figs 4, 5, *Turricula praepromensis* Eames. Pakistan, Rakhi Nala section, Eocene. 3 mm. (from Eames, 1952, Phil. Trans. Roy. Soc. London, ser. B, vol. 236, pl. 6, figs. 136, 137).

### *Turricula blagravei* (Vredenburg, 1921)

(Pl. 206, figs. 1, 2)

**Range**—Uppermost Ranikot of Jhirak, India (Post—Eocene).

**Remarks**—This species is definitely ancestral to the Recent *spurius* from which it differs only in the stronger more regular tuberculate spirals and fewer peripheral tubercles, which tend to be wider than long, whereas the reverse is the case in the Recent species.

#### **Measurements (mm.)—**

height	width
30.0 (estimated)	10.0

#### **Synonymy—**

- 1909 *Surcula voyseyi* (d'Archiac & Haime), Cossmann & Pissarro, Palaeont. Indica, new series, vol. 3, Mem. no. 1, p. 7, pl. 1, figs. 25-28 (non d'Archiac & Haime, 1854).
- 1921 *Surcula blagravei* Vredenburg, *nom. nov.* for *Surcula voyseyi*, Cossmann & Pissarro, 1909 (non d'Archiac & Haime, 1854), Records Geol. Surv. India, vol. 53, p. 87.
- 1928 *Surcula blagravei* Vredenburg, Palaeont. Indica, new series, vol. 10, Mem. no. 4, p. 21.

### *Turricula thurstoni* (E. A. Smith, 1896)

**Range**—Off Trincomalee, Ceylon, 200-350 fathoms (Smith, 1896) and off the Travancore coast, India, 360 fathoms (Smith, 1904).

**Remarks**—This species has never been figured and I have no information concerning the type, which presumably is in the Indian Museum, Calcutta. However, Annandale & Stewart, 1909, in their Illustrations, Zoology of the Investigator Expedition, who figured almost all the species described in E. A. Smith's series of papers on the *Investigator* mollusca did not include *Pleurotoma* (*Surcula*) *thurstoni*. From the original description it would appear that *thurstoni* resembles *spurius* but is larger and proportionately narrower.

**Description** (original)—“Testa fusiformis, albida, periostraco tenuissime dilute olivaceo induta; anfractus normales 10, paulo infra medium angulati, supra concavi, infra suturam tenuiter plicati, ad angulum oblique et fortius plicati, infra medium spiraliter striati, supra laeves, ultimus antice rostratus, lineis incrementi flexuosis aliisque transversis sculptus; apertura longit. totius  $\frac{1}{2}$  fere aequans; labrum tenue, superne late et subprofunde sinuatum. Longit. 40 millim., diam. 13 mm.; apertura cum canali 19 longa, in medio 5 lata. Hab. off Trincomalee, in 200-350 fathoms.”

“In general form recalling *P. javana* (L.). The nodules at the periphery are rather similar, but the fine sutural plicae are wanting in that species”.

#### **Synonymy—**

- 1896 *Pleurotoma* (*Surcula*) *thurstoni* E. A. Smith, Ann. Mag. Nat. Hist., Ser. 6, vol. 18, p. 369.
- 1904 *Pleurotoma* (*Surcula*) *thurstoni* E. A. Smith, Ann. Mag. Nat. Hist., Ser. 7, vol. 13, p. 457.

### *Turricula thangaensis* (Vredenburg, 1921)

(Pl. 199, fig. 1)

**Remarks**—This species is known to me only from the original illustration of the rather poorly preserved and incomplete holotype. As its author remarked, the species undoubtedly belongs to the typical “*javana-tuberculata*” series, in fact it may well be the forerunner of the deep-water Persian Gulf species, *navarchus* Melvill & Standen. From this Recent species the Thanga fossil differs in having both the peripheral nodules and the subsutural ones equally and strongly developed.

*Measurements (mm.)—*

height	width
21.0	8.0

*Synonymy—*

1921 *Surcula thangaensis* Vredenburg, Rec. Geol. Surv. India, vol. 53 no. 2, p. 88, pl. 12, fig. 5.

*Records—BURMA:* Thanga (Kama Stage, Aquitanian Miocene).

***Turricula praepromensis* Eames, 1952**

(Pl. 199, figs. 4, 5)

*Remarks—*This species is based upon material both fragmentary and immature, but the style of sculpture suggests that its author's generic choice was a reasonable supposition. Eames considered that his species was closely allied to *Surcula promensis* Vredenburg, 1921, from the Obogon Alternations (Middle Miocene) of Kyaungon, Myaukmigon and Thanga in Burma.

*Measurements (mm.)—*

height	width
3 +	2.6

*Synonymy—*

1952 *Turricula praepromensis* Eames, Philos. Trans. Roy. Soc. of London, ser. B, vol. 236, p. 129, pl. 6, figs. 136, 137.

*Types—*The holotype is in the British Museum (Natural History).

*Records—PAKISTAN:* Rakhi Nala section, Upper Chocolate Clays, Eocene.

***Turricula promensis* (Vredenburg, 1921)**

(Pl. 200, figs. 1, 2)

*Range—*Middle Miocene of Kyaungon, Myaukmigon, Thanga, Burma.

*Remarks—*Vredenburg considered his species to be a premutation of the Recent *javana* (Linnaeus). From the Recent species the Burma fossil is readily distinguished by its wider spire angle, heavier subsutural margining fold and a more bluntly rounded peripheral angle. Also the spiral sculpture is consistently minutely granular, not smooth as in the Recent species. By its granular spiral sculpture *promensis* shows resemblance to the *spurius* group as well, but in that group the spirals tend to be fewer and more definitely gemmate and the subsutural margining fold is invariably sculptured with two, not three or more, threads.

*Description—*Shell robust, of moderate size, 35 mm. (1 $\frac{3}{8}$  inches) in height, broadly fusiform, with a tall broadly conic spire and a moderately long, flexed, unnotched anterior canal. Spire

slightly less than height of aperture plus canal. Post-nuclear whorls estimated at ten, with a broad subsutural margining fold which bears up to six or seven spiral threads of unequal development. This is followed by a steep, wide, slightly concave shoulder slope below which is a bluntly rounded periphery just below the lower third whorl height. Numerous, short, protractively oblique, axial folds cross the periphery but fade out at about the lower suture. The whole surface bears closely-spaced, granulate cords and threads, those on the shoulder slope being considerably weaker than the rest. Interior of the aperture with distant, sharply raised, spiral lirations.

*Measurements (mm.)—*

height	width
35.0	16.0

*Synonymy—*

1921 *Surcula promensis* Vredenburg, Rec. Geol. Surv. India, vol. 51 no. 3, p. 304, pl. 8, figs. 1-3.

***Turricula promensis subspecies silistrensis* (Vredenburg, 1921)**

(Pl. 200, figs. 3, 4)

*Range—*Middle Miocene of Bagmara, Dalu, Burma.

*Remarks—*There is insufficient data to determine at this stage if Vredenburg's *silistrensis* is an ecotype, a subspecies or a full species. In its adult whorls the subsutural fold is much heavier, the shoulder slope more deeply concave and the

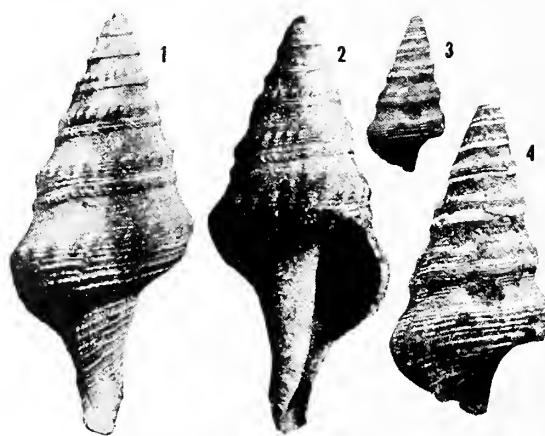


Plate 200. Figs. 1, 2, *Turricula promensis* (Vredenburg), Middle Miocene of Kyaungon, Myaukmigon, Thanga, Burma. 35.0 mm. (from Vredenburg, 1921, pl. 8, figs. 1b, 1d). Figs. 3, 4, *Turricula promensis silistrensis* (Vredenburg). Middle Miocene of Bagmara, Dalu, Burma (from Vredenburg, 1921, pl. 8, figs. 4a, 4b).



axial sculpture subobsolete, but the early post-nuclear whorls appear to be closely similar to those of the typical species. Vredenburg introduced still another name, *dimorpha*, for a "race" from Garo Hills, in which "the nodes disappear entirely on the last spire-whorl and body-whorl, while the spiral threads over the entire surface of the last spire-whorl and the corresponding part of the body-whorl become very conspicuous and uniform."

*Measurements (mm.)—*

height	width
50.0	18.0

*Synonymy—*

1921 *Surcula promensis* var. *silistrensis* and race *dimorpha*, Vredenburg, Rec. Geol. Surv. India, vol. 51 no. 3, p. 308, pl. 8, fig. 4.

**Turricula ceylonica (E. A. Smith, 1877)**

(Pl. 201, figs. 2, 3)

*Range*—Ceylon, in shallow water, and southern India.

*Remarks*—This species is a small but stout and boldly sculptured turriculid, comparable in size with *Paradrillia* but unlike that genus in the form of the anterior canal, which is relatively long and straight, not truncated and twisted. The protoconch also is not comparable with that of

*Paradrillia*, for it lacks carination and terminates in a vertical, ill-defined edge, not produced forward in a sinuous sweep.

*Description*—Shell small, 19-21 mm. ( $\frac{3}{4}$  inch) in height, with a tall spire and a moderately long anterior canal; solid, sculptured with strong spiral cords and a fused double row of peripheral nodules. Spire about one and a third times height of aperture plus canal; angle  $30-32^\circ$ . Whorls 11, including a small, smooth, papillate protoconch of  $1\frac{1}{2}$  whorls, the tip asymmetric and slightly inrolled, followed by a half whorl of stout brephic axials (Pl. 211 fig. 2). These axials actually commence weakly just prior to the terminal edge. Spire-whorls sculptured with a strong subsutural fold composed of two stout, linear-spaced, smooth, rounded spiral cords, a moderately wide and deeply concave shoulder, with a fine crisp spiral thread at its lower extremity, followed by a massive flange-like peripheral carina composed of two strong spiral cords crossed obliquely by closely-spaced, vertically-fused, rounded nodules, 18-22 per whorl. The bicarinate keel occupies the lower third of the whorl height, with part of the uppermost spiral only, emergent at the lower suture. Base and neck with about 10 primary spirals; intermediate threads over the neck and fasciole only. Sinus deep and wide, occupying the shoulder concavity, its apex broadly rounded. Outer lip thin and arcuately and forwardly produced. Anterior canal of moderate length and only weakly flexed, broadly and shallowly notched and with a slight false umbilical chink. The whole surface with closely-spaced growth lines which decussate the subsutural fold and the basal spirals. Colour creamy-white, faintly and irregularly marbled with light brown.

*Measurements (mm.)—*

height	width	
21.1	7.7	Ceylon, Mannar, 3 fms.
20.5	7.4	Ceylon, Mannar, 3 fms.
20.0	7.7	Ceylon, Mannar, 3 fms.
19.5	7.0	Ceylon (syntype, Brit. Mus.)

*Synonymy—*

1877 *Pleurotoma ceylonica* E. A. Smith, Ann. Mag. Nat. Hist., ser. 4, vol. 19, p. 489.

*Types*—Three syntypes in the British Museum (Natural History).

*Records*—CEYLON: (type locality) Mannar, 3 fathoms (Winckworth coll., Brit. Mus.); dredged, S.W. of Karaitivu Island and N. tip of Eluvativu Island (G. & M. Kline, Jan. 1957, ANSP.). INDIA: Madras (Winckworth coll., Brit. Mus.)

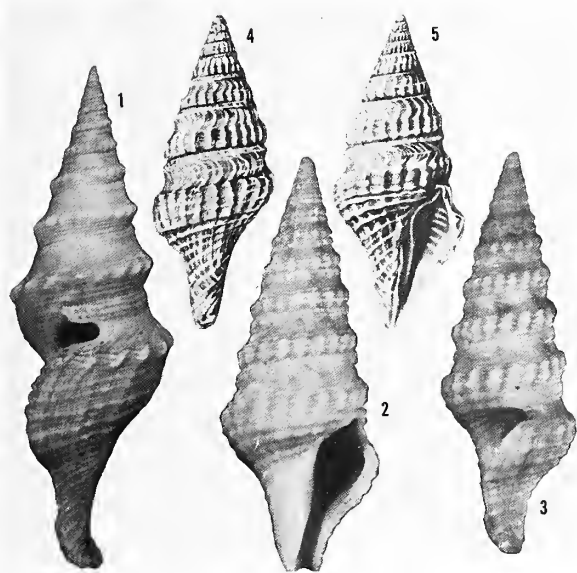


Plate 201. Fig. 1, *Turricula javana* (Linnaeus). Bombay, India. 70.0 mm. Figs. 2, 3, *Turricula ceylonica* (E. A. Smith). Mannar, Ceylon, 3 fathoms. 20. mm. Figs. 4, 5, *Turricula kelirensis* (K. Martin). West Progo Beds, lower Miocene of Kembang Sokkoh, Java. 13.0 mm. (from K. Martin, 1916, pl. 1, figs. 11, 12).

***Turricula kelirensis* (K. Martin, 1916)**

(Pl. 201, figs. 4, 5)

*Range*—West Progo Beds, lower Miocene of Kembang Sokkoh, Java, Indonesia.

*Remarks*—This small species, 13 mm. ( $\frac{1}{2}$  inch) in height, seems to be related to the Recent *ceylonica* (E. A. Smith). From that species it differs chiefly in having only a slight subsutural fold, a much wider shoulder sulcus, and fewer basal spirals, which are plain, not gemmate. The axial sculpture is for the most part lamellate, but thickens over the peripheral area, where three or four spirals are rendered closely and strongly gemmate. The axials impart distinct crowded sinus curves over the shoulder slope and also cause a clathrate effect on the base, where they cross the spirals at right angles. The style of sculpture is more like that of *Paradrillia agalma* (E. A. Smith) from Ceylon, but *kelirensis* is not a *Paradrillia*, as shown by its moderately long and straight anterior canal.

*Measurements* (mm.)—

height	width
13.0	—

*Synonymy*—

- 1916 *Surcula kelirensis* K. Martin, Die Altmioocene Fauna des West-Progegeb. auf Java. Samml. Geol. Reichsmus., Leiden, vol. 2 no. 6, p. 228, pl. 1, figs. 11, 12.  
 1919 *Surcula kelirensis* K. Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula kelirensis* K. Martin, van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

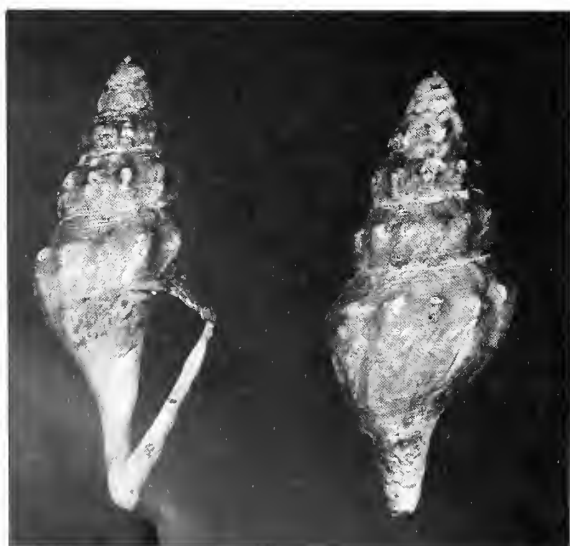


Plate 202. *Turricula? paupera* (Watson). Off Aru Islands, 800 fathoms, Arafura Sea, holotype. 40.1 mm. Photo courtesy of S. P. Dance.

***Turricula paupera* (Watson, 1881)**

(Pl. 202)

*Range*—Off the Aru Islands, Arafura Sea, Indonesia; 800 fathoms.

*Remarks*—There are three co-types of this species in the British Museum collection; two of them have rounded lower whorls with obsolescent sculpture but the third is angulate and strongly and axially costate throughout. The last mentioned specimen must be regarded as the holotype, although it differs considerably from the obviously badly drawn and somewhat idealised figure in the *Challenger* Report. Watson's very lengthy description is not very useful since it is a composite, covering both the typical and the smooth form. More material is required before this smooth form can be evaluated but its early whorls do bear sculpture approximating that of the holotype specimen.

*Description*—Shell of moderate size, 40.1 mm. ( $1\frac{5}{8}$  inches) in height, biconic-fusiform, with a tall spire, evidently, when complete, slightly taller than the aperture plus the moderately long rather straight unnotched anterior canal. Early whorls eroded away; the three remaining spire-whorls bluntly angulate just above middle whorl height. Suture not margined; shoulder slope lightly concave and steeply descending. Axial sculpture of strong, bluntly rounded, slightly protractively oblique folds, which commence strongly at the periphery but fade out before reaching the lower suture. The whole surface densely and spirally lirate. "Colour buff below the yellow epidermis which is coarse and harsh, but not thick" (Watson). Sinus broadly arcuate, rather shallow and occupying most of the shoulder slope.

*Measurements* (mm.)—

height	width	
40.1	16.2	lectotype
33.5	13.5	one of the smooth co-types

*Synonymy*—

- 1881 *Pleurotoma* (*Drillia*) *paupera* Watson, Journ. Linn. Soc., vol. 15, p. 411.  
 1886 *Pleurotoma* (*Typhlomangelia*) *paupera* Watson, Challenger Zool., vol. 15, p. 317, pl. 25, fig. 3.

*Types*—The lectotype and two co-types in the British Museum (Natural History). I am indebted to Mr. S. P. Dance for the photographs of the lectotype.

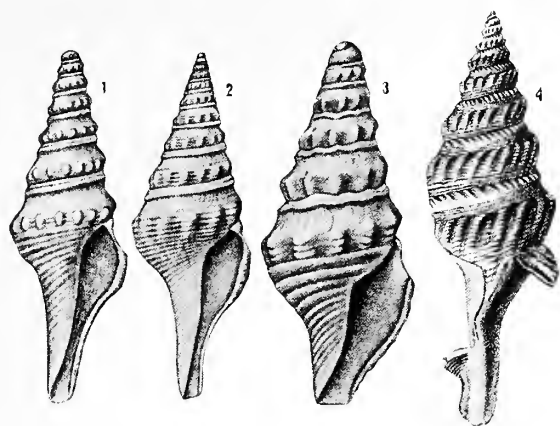


Plate 203. Fig. 1, *Turricula gemmulaeformis* (Thiele). Padang, Sumatra. 10 mm. (from Thiele, 1925, pl. 24, fig. 20). Fig. 2, *Turricula sumatrana* (Thiele). West Sumatra. 19.0 mm. (from Thiele, 1925, pl. 24, fig. 18). Fig. 3, *Turricula aethiopica* (Thiele). East Africa, off Kenya, 693 metres. 9.0 mm. (from Thiele, 1925, pl. 24, fig. 17). Fig. 4, *Turricula obliquicosta* (von Martens). Off the west coast of Sumatra, 1143 metres. 47 mm. (from von Martens, 1903, pl. 2, fig. 1).

### *Turricula sumatrana* (Thiele, 1925)

(Pl. 203, fig. 2)

*Range*—West Sumatra Island, Indonesia.

*Remarks*—This shell is known to me only from the original description and figure, but these suggest close alliance with *nelliae spurius* (Hedley), the chief differences being, that the axials, although relatively short, are fold-like, rather than tubercular, and the overriding spirals are plain throughout, not beaded or tuberculate.

*Description*—Shell small, 19 mm. ( $\frac{3}{4}$  inch) in height, somewhat broadly fusiform, with tall spire and long almost straight unnotched anterior canal. Spire height equal to that of aperture plus canal. Whorls 9, including a small smooth globular protoconch of  $1\frac{1}{2}$  whorls. Whorls firstly with two strong linear spaced spiral cords submarginating the suture, followed by a rather wide shallowly concave shoulder area to the broadly rounded axially plicate peripheral angle, which occupies a little more than the lower third of whorl height. Axials short, broadly rounded, fold like, slightly protractively oblique, about 12 per whorl, commencing abruptly at the lower extremity of the shoulder area, and extending a little below the level of the lower suture on to the upper base. Spiral sculpture consisting of 3-4 fine threads over the shoulder sulcus, 4 strong cords overriding the peripheral axials and continued below, linear-spaced, and gradually diminishing

to the end of the anterior canal. Sinus indicated as moderate, with broadly rounded apex at the middle of the shoulder sulcus. Colour light brownish.

#### *Measurements (mm.)—*

height	width
19.0	6.5

#### *Synonymy—*

1925 *Surcula sumatrana* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped. vol. 17, Gastr. 2, p. 335, pl. 24, fig. 18.

*Types*—The holotype is in the Zoological Museum, East Berlin.

*Records*—West Sumatra.

### *Turricula gemmulaeformis* (Thiele, 1925)

(Pl. 203, fig. 1)

*Range*—Padang, Sumatra, Indonesia.

*Remarks*—Another species known to me only from the original description and figure. It resembles *sumatrana* (Thiele) in having a prominent bicingulate subsutural marginating but the shell is more narrowly fusiform and the peripheral axials are reduced to nodes, with the two uppermost spiral cords interstitial, not overriding the nodes, which gives a *Gemmula*-like appearance to the shell. Whorls 7, but the apical whorls are missing. Shoulder sulcus wide, steeply descending. Colour yellowish.

#### *Measurements (mm.)—*

height	width
10 +	3.25

#### *Synonymy—*

1925 *Surcula gemmulaeformis* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped. vol. 17, Gastr. 2, p. 336, pl. 24, fig. 20.

*Types*—The holotype is in the Zoological Museum, East Berlin.

### *Turricula aethiopica* (Thiele, 1925)

(Pl. 203, fig. 3)

*Range*—Off Kenya, East Africa, in 693 metres.

*Remarks*—This species is known to me only from the original description and figure, which indicate an immature shell.

*Description*—Shell small, 9 mm ( $\frac{3}{8}$  inch) in height, fusiform-biconic, with spire taller than the aperture plus canal. Whorls 7, of which two form the smooth globular relatively large protoconch. It resembles both *gemmulaeformis* (Thiele) and *sumatrana* (Thiele) in having a prominent bicingulate subsutural marginating (mainly fused into one in this species). Angula-



tion just below middle whorl height, sharp, from which erect axial folds, overridden by three spiral cords, extend to the lower suture but not on to the base, where they are replaced by four strong spiral cords, followed by diminishing finer spirals over the neck and anterior end. Sinus indicated as broadly rounded, shallow, occupying the whole of the rather wide shoulder sulcus.

*Measurements (mm.)—*

height	width
9.0	3.5

*Synonymy—*

1925 *Surcula aethiopica* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped. vol. 17, Gastr. 2, p. 237, pl. 24, fig. 17. (in 693 meters; S. Lat. 1° 40.6'; E. Long. 41° 47.1')

*Types*—The holotype is in the Zoological Museum, East Berlin.

***Turricula obliquicosta* (von Martens, 1901)**

(Pl. 203, fig. 4)

*Range*—Off west coast of Sumatra 1143 meters.

*Remarks*—This species is known to me only from the original figure of the badly damaged holotype. Its author considered the species to be related to *javana* (Linnaeus) (i. e. *Turricula*), but it could equally well belong to *Comitas*. The form of the operculum, when known, will be the deciding factor.

*Description*—The shell is moderately large, 47 mm. (1<sup>3</sup>/<sub>8</sub> inches) in height, broadly fusiform, and with distinctive sculpture of numerous protractively oblique axial folds, extending from the rounded peripheral angle, at two thirds whorl height, to below the level of the lower suture on the upper part of the base. The shoulder sulcus is deeply concave, but above, there is a distinct subsutural narrow fold, which is crowded with rather strong retractive axial plications. Distinct, somewhat wavy spirals encircle all the post-nuclear whorls, both within the shoulder sulcus and over the rest of the shell, overriding the axials. The spire is probably taller than the height of the aperture plus canal, but it is impossible to determine this from the incomplete unique holotype. Martens did not mention the protoconch, which is probably either missing or eroded. The colour is described as “flavido-grisea”.

*Measurements (mm.)—*

height	width
47 +	19 +

*Synonymy—*

1901 *Pleurotoma (Surcula) obliquicosta* Martens, Sitzungsberichte d. Gesell. naturf. Freunde, Berlin, p. 16. (1143 meters; N. Lat. 1° 48'; E. Long. 96° 53'; globigerina ooze).

1903 *Surcula obliquicosta* von Martens, Gastrop. deutschen Tiefsee-Exped. für 1898-99, vol. 7, p. 80, pl. 2, fig. 1.

### Species Probably in *Turricula*

#### ?*Turricula pulchra* (Schepman, 1913)

(Pl. 204, figs. 3, 4)

*Range*—Indonesia, Banda Sea, 462 metres.

*Remarks*—This stout broadly fusiform-biconic shell is known to me only from Schepman's detailed description and excellent figure. The indicated moderately deep broadly arcuate sinus, occupying the whole of the shoulder area is in accord with inclusion in the turriculids. Unfortunately both the protoconch and the operculum are unknown.

The *Nassarius*-like shape, prominent protractively flexuous axials, crossed by numerous spiral cords, which become laterally compressed tubercles at and below the periphery, as well as a thickening of the axial growth lines above, to form a subsutural margin, are the distinctive features of this shell.

*Description*—(original) "Shell shortly fusiform, with short canal and pyramidal spire, rather thin, white. Nucleus wanting. Remaining whorls 6, angular, separated by a conspicuous, waved suture, their upper excavated. Sculpture consisting of narrow axial ribs, 14 in last whorl, oblique in upper whorls, elegantly flexuous in last one and a row of oblique, short plicae, on a faint subsutural rib; the axial ribs end in rather sharp tubercles in their upper part at the limit of excavation; the ribs are crossed by narrow spiral lirae, 3 more conspicuous and some fainter ones on penultimate whorl, numerous, rather unequal ones on last whorl; in crossing the ribs, they produce still 2 fainter tubercles on the lirae of penultimate whorl; numerous ones on last whorl, but not on canal, where the ribs disappear; moreover the shell is crossed by very faint growth-striae, more conspicuous in excavation and fine spiral striae, of which about 2 in excavation. Aperture oval, angular above, ending in a short, wide canal below, slightly directed to the left; peristome thin, broken, according to growth-lines with a moderately wide and deep sinus, then protracted; columellar margin concave above, slightly tortuous at the canal, with a thin layer of enamel; interior of aperture smooth, white."

#### *Measurements (mm.)*—

height	width
17.5	8.0

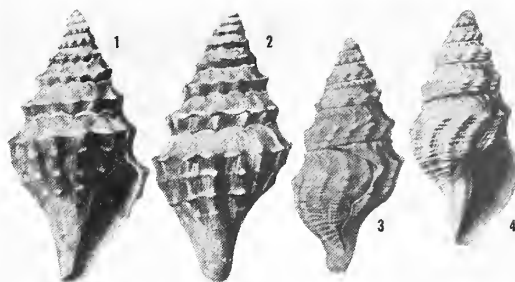


Plate 204. Figs. 1, 2, *Turricula biconica* (Schepman). Indonesia, Banda Sea, 462 metres. 8.7 mm. Figs. 3, 4, *Turricula pulchra* (Schepman). Banda Sea, 462 metres. 17.5 mm. (from Schepman, 1913, pl. 28, figs. 2, 4).

#### *Synonymy*—

1913 *Surcula pulchra* Schepman, Siboga Exped., vol. 49, pt. 1e, sect. 5, p. 426, pl. 28, fig. 2.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—INDONESIA, Banda Sea, 5° 54.5' S., 120° 19.2' E., 462 metres, fine grey and green mud.

#### *Turricula biconica* (Schepman, 1913)

(Pl. 204, figs. 1, 2)

*Range*—Indonesia, Banda Sea, 462 metres.

*Remarks*—This is another problematic species known to me only from Schepman's detailed description and excellent figure. The protoconch is of 2 convex whorls, at first smooth but the second whorl is obliquely costulate. The biconic shape and crisp spirals, raised into vertically compressed tubercles where they cross the axials are the distinctive features of this shell.

*Description*—(original) "Shell biconical, with short canal, rather thin, white. Whorls 8, of which about 2 form a convexly whorled nucleus, which seems to be at first smooth, the second whorl being obliquely costulate, postnuclear whorls separated by a conspicuous, distinctly waved suture, angular, excavated above, with rather narrow axial ribs, 14 in number on last whorl, scarcely indicated in excavation; the whorls are divided by a strong keel, consisting of depressed tubercles, forming the upper part of ribs, at the base of excavation; moreover there are 3 remote spirals on the scarcely contracted last whorl, which, in crossing the ribs, make them beaded, and 2 or 3 very faint, plain ones on canal; in the upper whorls the uppermost of these lirae is nearly covered by the suture and causes the conspicuous waves, otherwise the shell is nearly smooth, but for very fine growth-lines, more conspicuous in the excavation. Aperture oblong, angular above, with a short open canal below;

peristome thin, broken, according to growth-lines with a shallow sinus above, then slightly protracted; columellar margin nearly straight, with a thin layer of enamel."

*Measurements (mm.)—*

height	width
8.7	4.5

*Synonymy—*

1913 *Surcula biconica* Schepman, Siboga Exped., vol. 49, pt. 1e, sect. 5, p. 427, pl. 28, fig. 4.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—INDONESIA: Banda Sea, 5° 54.5'S., 120° 19.2'E. 462 metres, fine grey and green mud.

***Turricula amplisulcus* (Barnard, 1958)**

(Pl. 205, fig. 3)

*Range*—Off South Africa, 80-196 fathoms.

*Remarks*—This and other new species of Barnard, 1958, are known to me only from the original descriptions and rather sketchy line drawings. Until the type material is examined the relationships of these species cannot be determined with accuracy.

*Description*—(original)—"Aperture subequal to spire. Protoconch 1½ whorls, diam. and alt. 1 mm., smooth (but somewhat corroded). Post natal whorls 7; profile of early whorls prominently shouldered, less prominently on later whorls, and rounded on body whorl. Oblique axial ribs c.18 on middle whorls, not reaching suture below; crossed by well-marked spiral lirae, 2 on 3rd and 4th whorls, increasing to 5-6 on last whorl, c.10 additional lirae on base, without or with only feeble intermediaries. On body whorl the axial ribs indicated only by slight thickenings on the lirae. Sulcus broad forming half the whorl in early whorls, nearly half in later whorls, crossed by fine growth-lines only. Lip sinus broad and moderately deep. Canal long. White."

*Measurements (mm.)—*

height	width
29.0	11.0

*Synonymy—*

1958 *Surcula amplisulcus* Barnard, Ann. S. African Museum, vol. 44, p. 147, fig. 22a.

*Types*—Holotype in the South African Museum, Cape Town.

*Records*—SOUTH AFRICA: off Table Bay, 196 fathoms; off west coast of Cape Peninsula, 120 fathoms, 80-100 fathoms.

***Turricula sulcancellata* (Barnard, 1958)**

(Pl. 205, fig. 2)

*Range*—Off South Africa, 130-300 fathoms.

*Remarks*—Barnard considered his species very similar to *Pleurotoma (Surcula) obliquicosta* Martens, 1901, from off Sumatra in 1143 metres.

*Description*—(original)—"Aperture subequal to spire. Protoconch 1½ whorls, smooth. Post-natal whorls 6; profile rounded but with a slight shoulder. Oblique axial ribs 18 on early whorls, 20-21 on later whorls, not quite reaching suture of succeeding whorl, and becoming feeble and obsolescent on body whorl, upper ends projecting above sulcus and somewhat tubercular; spiral lirae 6 on early whorls, becoming more numerous on later whorls, with (especially on body whorl) finer intermediaries. Sulcus concave, with regular retrorse curved axial plicae, 3-5 times as numerous as the ribs, crossed by spiral lirae forming a cancellate sculpture, somewhat more conspicuous on the early whorls. Lip sinus wide but shallow. Canal short. White."

*Measurements (mm.)—*

height	width
31.0	12.0

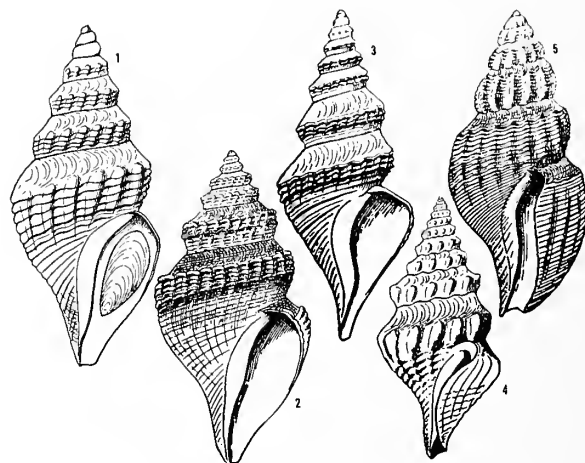


Plate 205. Fig. 1, *Comitas saldanhae* (Barnard), Saldanha Bay, 31 fathoms. 46 mm. (from Barnard, 1958, p. 110, fig. 7). Fig. 2, *Turricula sulcancellata* (Barnard). Off Cape Point, 130-300 fathoms, South Africa. 31.0 mm. (from Barnard, 1958, p. 146, fig. 22c). Fig. 3, *Turricula amplisulcus* (Barnard). Off Table Bay, 196 fathoms, South Africa. 29.0 mm. (from Barnard, 1958, p. 146, fig. 22a). Fig. 4, *Turricula scalaria* (Barnard). Off Cape Point, 480-800 fathoms, South Africa. 24.0 mm. (from Barnard, 1958, p. 146, fig. 22d). Fig. 5, *Turricula faurei* (Barnard). Agulhas Bank, 80-100 fathoms, South Africa. 21.0 mm. (from Barnard, 1958, p. 146, fig. 22b).



*Synonymy*—

1958 *Surcula sulcancellata* Barnard, Ann. S. African Museum, vol. 44, p. 145, fig. 22c.

*Types*—Holotype and four paratypes in the South African Museum, Cape Town.

*Records*—SOUTH AFRICA: off Cape Point, 130-300 fathoms.

**Turricula scalaria (Barnard, 1958)**

(Pl. 205, fig. 4)

*Range*—Off South Africa, 480-800 fathoms.

*Remarks*—The general facies of this species, as judged from the original figure, suggests *Paradrillia* but the protoconch is different and the characteristic heavy subsutural margining of *Paradrillia* is absent.

*Description*—(original) “Aperture a little shorter than spire. Protoconch  $2\frac{1}{2}$  whorls, diam. and alt. c. 0.6 mm., apex very small, diam. 0.25 mm., smooth. Postnatal whorls 8, turreted, with prominent tubercular shoulder. Tubercles 12-13 on early whorls, 11-12 on middle whorls, increasing to 14-15 on body whorl, oval or slightly oblong (axially) strongest at the shoulder, weaker below and just reaching suture of succeeding whorl, indicated on base by slight swellings on the spiral lirae; crossed on early whorls by 2 (in one specimen 3) spiral lirae, which become obsolete on later whorls, but the lower one traceable and making the profile of the tubercles slightly rectangular; spiral lirae well spaced on upper part of base, closer together below, no intermediaries. Suture undulate. Sulcus broad, forming nearly half the whorl, crossed by fine growth-lines only. Lip sinus broad and rather deep. Canal short. White.”

*Measurements (mm.)*—

height	width
24.0	10.0

*Synonymy*—

1958 *Surcula scalaria* Barnard, Ann. S. African Museum, vol. 44, p. 146, fig. 22d.

*Types*—Holotype and 6 paratypes in the South African Museum, Cape Town.

*Records*—SOUTH AFRICA: off Cape Point, 480-800 fathoms.

**Turricula faurei (Barnard, 1958)**

(Pl. 205, fig. 5)

*Range*—South Africa, Agulhas Bank, 80-100 fathoms.

*Remarks*—This species, known to me only from Barnard's description and line drawing of

the unique holotype is difficult to place, even generically. The shape is bucciniform, with rounded whorls and only weakly subangled forming a narrow shoulder area. The spire is moderately tall and the body-whorl capacious with a very short but distinctly notched anterior canal. There is however a rather deep rounded turriculid style of posterior sinus which occupies the whole of the shoulder slope. In general facies the shell recalls, somewhat, *Surcula nierstraszi* Schepman, 1913, from the Arafura Sea in 1788 metres, but that species has a less capacious body-whorl and an unnotched anterior canal.

*Description*—(original) “Aperture subequal to spire. Protoconch corroded. Postnatal whorls 5, profile rounded, without shoulder. First whorl corroded; slightly oblique axial ribs 11 on 2nd whorl, 12 on 3rd, 15 on 4th and 16-17 on 5th (obscure on later half of whorl, but 2 clearly marked at outer lip), reaching suture below, obsolete on base; crossed by spiral lirae 4 on 2nd whorl, 5 on 3rd, 9 on 4th, and 10 plus intermediaries on 5th, c. 14 additional fine lirae on base passing into about 10 stronger and more widely spaced ones on rostrum. Suture undulate. Sulcus with numerous distinctly marked growth-lines, crossed by 1, 2 or (on last whorl) 3 fine spiral lirae. Lip sinus deep. Canal short. Pale buff.”

*Measurements (mm.)*—

height	width
21.0	9.3

*Synonymy*—

1958 *Surcula faurei* Barnard, Annals South African Mus., vol. 44, p. 147, fig. 22b.

*Types*—The holotype is in the South African Museum, Cape Town.

*Records*—SOUTH AFRICA: Brown's Bank, Agulhas Bank, 80-100 fathoms.

**Indian Tertiary Species****Turricula cullenii (Dey, 1962)**

*Range*—Miocene of Quilon, Kerala, India.

*Remarks*—The author of this species compared it with *Surcula promensis* Vredenburg, 1921, from which it was said to differ in the absence of nodes on the periphery of the body-whorl and in having a narrower sinus band.

The figures are too indistinct for reproduction here, but the original description is as follows:—*Description* (original)—“Shell of medium size, moderately fusiform, consisting of 8 or more whorls which are somewhat convex anteriorly

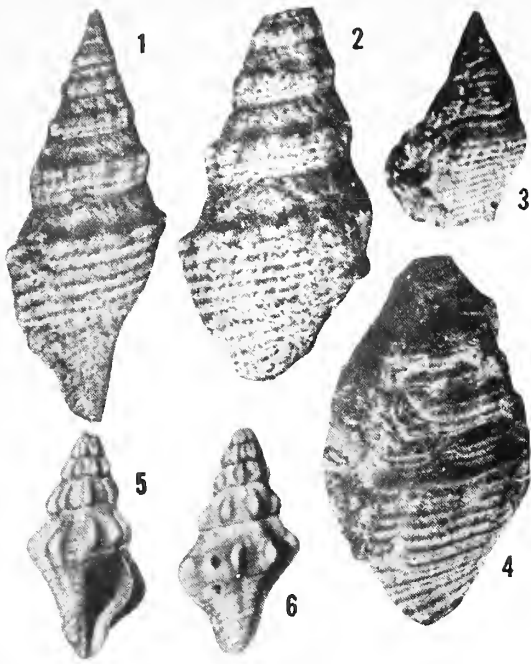


Plate 206. Figs. 1, 2, *Turricula blagrovei* (Vredenburg). Ranikot, Eocene, Jhirak, India. 30.0 mm. Fig. 2 is the holotype of the synonym, *Surcula voyseyi* Cossmann & Pissarro, 1909, pl. 7, figs. 25, 27. Figs. 3, 4, *Turricula indica* (Cossmann & Pissarro). Ranikot, Eocene, Jhirak, India (from Cossmann & Pissarro, 1909, pl. 1, figs. 31, 32). Figs. 5, 6, *Turricula* (s.l.) *pollii* (Icke & Martin). Upper Miocene of Nias Island, Sumatra (from Icke & Martin, 1907, pl. 14, figs. 8, 8a).

and concave posteriorly; suture linear, bordered anteriorly by a prominent band bearing a few spiral threads and slight nodosities; ornamentation of the convex shoulder consisting of obliquely elongated nodes or crenulations crossed by spirals; the concave ramp is marked by curved growth-lines indicating the broad and moderately deep sinus of the outer lip; the body-whorl appears to be of the same height as the spire, its whole surface being sculptured with spiral threads of 3 orders, those of the first order being particularly conspicuous and granulated by the intersection of raised growth-lines, aperture large, somewhat pyriform, contracted anteriorly into a terminal canal which is however, broken; columella glazed with a deposit of callus; internal wall of the shell, carrying delicate but sharply defined revolving lirae. Apex missing."

*Measurements (mm.)—*

height	width
25.0	12.0

*Synonymy—*

1962 *Surcula cullenii* Dey, Memoirs Geol. Surv. India. Pal. Indica, n. s., vol. 36, p. 95, pl. 8, figs. 24, 29.

*Types*—The holotype is in the collection of the Geological Survey of India, Calcutta.

*Turricula indica* (Cossmann & Pissarro, 1909)

(Pl. 206, figs. 3, 4)

*Range*—Uppermost Ranikot Eocene of Jhirak, India.

*Remarks*—This is a small depressed-biconic shell with undulating spiral sculpture. The main feature is a strong rounded subsutural fold and a deeply concave but narrow shoulder sulcus.

The material is fragmentary so the form of the anterior canal and also of the nuclear whorls is unknown. It seems to be satisfactorily placed in *Turricula* but it is not closely related to the "*tuberculata*", i. e. *spurius* series.

*Measurements (mm.)—*

height	width
15-16 estimated	5

*Synonymy—*

1909 *Surcula indica* Cossmann & Pissarro, Palaeont. Indica, new series, vol. 3, Mem. No. 1, p. 9, pl. 1, figs. 31, 32.

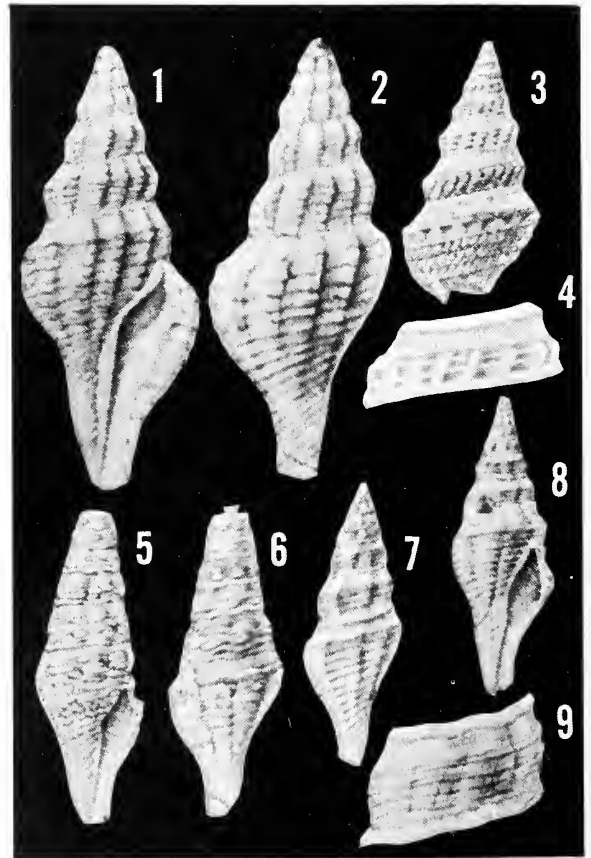


Plate 207. *Turricula* (sensu lato). Figs. 1, 2, *Turricula dril-liaeformis* (K. Martin). Lower Miocene to Pliocene of Batavia, Java. Figs. 3, 4, *Turricula javana tegalensis* (K. Martin). Pliocene? of Pangka, Java. Figs. 5, 6, *Turricula waringinensis* (K. Martin). Pliocene of Tji, Djadjar, Leuwimunding, Java. Figs. 7, 8, 9, *Turricula bantanensis* (K. Martin). Pliocene of Rajah, Tjilangkahan, Java. (all from K. Martin, 1895, pl. 5).

**Turricula voyseyi (d'Archiac & Haime, 1854)**

*Range*—Gaj beds near Karachi, India (Post-Eocene).

*Remarks*—Vredenburg (1925 l.c.) considered this species scarcely distinct from the Recent "*tuberculata*", i. e. *spurius*, even as a variety. The chief difference mentioned by Vredenburg, seems to be in the form of the subsutural fold. In "*tuberculata*" the fold is composed of two spirals but these increase to three in *voyseyi*.

In over fifty Recent specimens of *spurius* examined none had more than two subsutural spirals.

*Measurements (mm.)—*

height	width
35.0	18.0

*Synonymy—*

- 1854 *Pleurotoma voyseyi* d'Archiac & Haime, Descr. au foss. gr. numm. Inde, p. 305, pl. 29, fig. 10.  
 1925 *Surcula tuberculata* var *voyseyi* (d'Archiac & Haime), Vredenburg, Mem. Geol. Surv. India, vol. 50, p. 39

**Indonesian Tertiary Species****Turricula bantamensis (K. Martin, 1895)**

(Pl. 207, figs. 7-9)

*Range*—Pliocene of Rajah, Tjilangkahan, Java (type locality) and Pliocene of North Sumatra, Indonesia.

*Remarks*—By the well developed spiral and axial sculpture this species is probably a *Turricula* rather than a *Comitas*.

*Synonymy—*

- 1895 *Pleurotoma (Surcula) bantamensis* Martin, Die Foss. von Java, 1, Gast. Samml. Geol. Reichs-Mus., Leiden, p. 28, pl. 5, figs. 72, 73.  
 1919 *Surcula bantamensis* (Martin), Martin, Palaeozool. Kenntnis von Java, Leiden, p. 74.  
 1931 *Surcula bantamensis* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 219.

**Turricula drilliaeformis (K. Martin, 1895)**

(Pl. 207, figs. 1, 2)

*Range*—Lower Miocene to Pliocene of Batavia, Java (type locality) and upper Miocene to Pliocene of Timor.

*Remarks*—Judging from the well developed spiral and axial sculpture this species also is probably a *Turricula* rather than a *Comitas*.

*Synonymy—*

- 1895 *Pleurotoma (Surcula) drilliaeformis* K. Martin, Die Foss. von Java, vol. 1, Gast., Samml. Geol. Reichs-Mus., Leiden, p. 30, pl. 5, figs. 76, 77.  
 1919 *Surcula drilliaeformis* (Martin), K. Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula drilliaeformis* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

**Turricula waringinensis (K. Martin, 1895)**

(Pl. 207, figs. 5, 6)

*Range*—Pliocene of Java and lower Miocene of Nias Island, Sumatra, Indonesia.

*Remarks*—This Javanese fossil seems to be turriculid but it is unlike any described species. The shell is of moderate size, elongate-fusiform, with a slender spire, taller than the aperture plus the canal, which is moderately long and straight. Protoconch and early whorls missing. Spire outlines almost straight. Sculpture of strong spirals which develop losenge-shaped nodes where they cross broadly rounded axial folds. On the spire-whorls there is firstly a prominent smooth subsutural cord, then a steeply descending lightly concave shoulder sulcus, followed by two spiral series of nodulose cords. On the body-whorl there are about eight nodulose cords followed by about nine plain spirals.

*Synonymy—*

- 1895 *Pleurotoma (Surcula) waringinensis* Martin, Die Foss. von Java, vol. 1, Gast., Samml. Geol. Reichs-Mus., Leiden, p. 29, pl. 5, fig. 74.  
 1919 *Surcula waringinensis* (Martin), Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula waringinensis* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

*Records*—JAVA: Tji Djadjar, Leuwimunding (Pliocene) (type locality); SUMATRA: Nias Island (lower Miocene) (Vlerk, 1931).

**Turricula everwijni (K. Martin, 1884)**

(Pl. 208, figs. 3, 4)

*Range*—Java, Miocene at Ngembak, Indonesia.

*Remarks*—It is difficult to evaluate this species upon the evidence of the description and figure alone. The shell is ovate and densely axially and spirally sculptured. The detail of the spire whorls (Martin, 1884, pl. 4, fig. 65) shows a very deep and prominent subsutural fold sculptured with closely spaced retractive axials, which continue protractively across a rather narrow shoulder sulcus to the median placed peripheral angle. Below this there are numerous erect narrowly



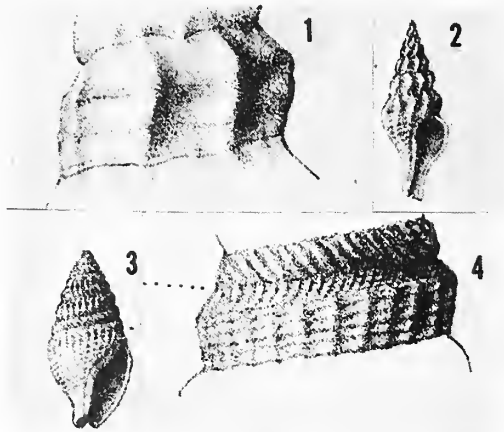


Plate 208. Figs. 1, 2, *Comitas dijki* (K. Martin). Upper Miocene at Grissee, from bore at 466 metres, Java. Figs. 3, 4, *Turricula?* *everwijni* (K. Martin). Miocene of Ngembak, Java (both from K. Martin, 1884, pl. 4, figs. 62 & 63).

rounded axials, 22 or 24 per whorl, and these are crossed by 4-5 crisp spiral cords, which render the axials weakly gemmate at the points of intersection. The chevron trend of the axials over the shoulder slope indicate a turriculid style of sinus, but upon the evidence available to me, a more exact systematic location is conjectural.

#### *Synonymy*—

- 1884 *Pleurotoma* (*Surcula*) *everwijni* Martin, Tiefbohr auf Java, Samml. Reichs-Mus., Leiden, vol. 3, p. 64, pl. 4, fig. 65.  
 1919 *Surcula everwijni* (Martin), Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula everwijni* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 220

#### *Turricula gembacana* (K. Martin, 1884)

*Range*—Miocene of Ngembak, Java, Indonesia.

*Remarks*—This is a small, smooth, ovoid-fusi-form shell, resembling a *Pisania*. No size is given in the text so it is presumed that the figure, measuring 13 mm., represents natural size. In the absence of material the species is retained, *sensu lato*, in the author's original allocation = *Turricula*.

#### *Synonymy*—

- 1884 *Pleurotoma* (*Surcula*) *gembacana* Martin, Tiefbohr auf Java, Samml. Reichs-Mus., Leiden, vol. 3, p. 63, pl. 4, fig. 63.  
 1919 *Surcula gembacana* (Martin), Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula gembacana* (Martin), von der Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

#### *Turricula wanneri* (K. Martin, 1914)

(Pl. 209, figs. 5, 6)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java, Indonesia.

*Remarks*—This fossil is still another member of the *spurius* group. It is of small size, 14 mm. ( $\frac{1}{2}$  inch) in height, with a tall spire and moderately long straight anterior canal, more like that of *nelliae* than that of *spurius*. The sculpture is of numerous prominent rounded axial folds, subobsolete over the shoulder sulcus, and many crisp rather narrow spiral cords which undulate over the axials rather than rendering them gemmate. There are 3-4 spiral cords on the spire and there is a slightly wider interspace between each pair. Below, the two uppermost basal spirals are much stronger than the rest.

#### *Measurements* (mm.)—

height	width
14.0	—

#### *Synonymy*—

- 1914 *Surcula wanneri* Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2 no. 4, p. 118, pl. 1, figs. 25, 26.  
 1919 *Surcula wanneri* Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula wanneri* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220

#### *Turricula jogjacartensis* (K. Martin, 1931)

(Pl. 209, figs. 1, 2)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java, Indonesia.

*Remarks*—This species has a superficial resemblance to *spurius* (Hedley) (= *tuberculata* Gray), but has a longer canal, which is almost straight, and there is no subsutural fold; in consequence the sinus is more broadly rounded and occupies most of the shoulder slope.

#### *Measurements* (mm.)—

height	width
32.0	—

#### *Synonymy*—

- 1931 *Surcula jogjacartensis* Martin, Moll. Obereocan von Nanggulan. Wetens. Meded. Mijnb. Ned.-Indie, vol. 18, p. 5, pl. 1, figs. 11, 11a.  
 1931 *Surcula jogjacartensis* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

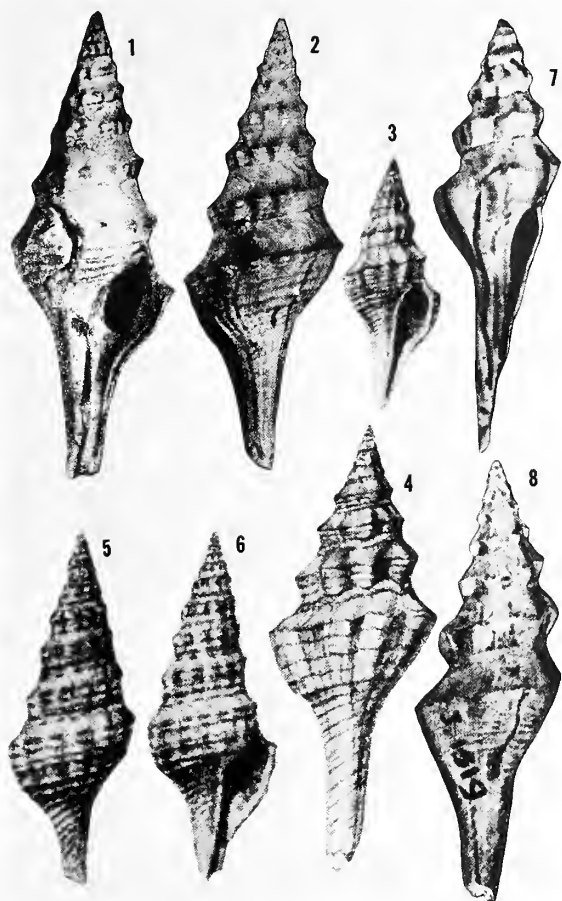


Plate 209. Figs. 1, 2, *Turricula jogjacartensis* (K. Martin). Nanggulan beds, Miocene of Kali Puru, Java. 32.0 mm. (from K. Martin, 1931, pl. 1, figs. 11, 11a). Figs. 3, 4, *Turricula lepidota* (K. Martin). Nanggulan beds, Miocene of Kali Puru, Java. 9.0 mm. (from K. Martin, 1914, pl. 1, figs. 23, 24). Figs. 5, 6, *Turricula wanneri* (K. Martin). Nanggulan beds, Miocene of Kali Puru, Java. 14.0 mm. (from K. Martin, 1914, pl. 1, figs. 25, 26). Figs. 7, 8, *Turricula plagiaria* (K. Martin). Nanggulan beds, Miocene of Jana. 25.0 mm. (from K. Martin, 1931, pl. 1, figs. 9, 10).

### *Turricula lepidota* (K. Martin, 1914)

(Pl. 209, figs. 3, 4)

**Range**—Nanggulan Beds, Miocene of Kali Puru, Java, Indonesia.

**Remarks**—This small fossil, ca 9 mm. ( $\frac{1}{3}$  inch) in height is rather broadly fusiform, sharply medially carinate, tall spired, and with a long straight anterior canal. The sculpture is of strong undulated axial folds, about 7 per whorl, which commence abruptly at the periphery and extend strongly to the lower suture, thence fading out gradually on the upper part of the base. The spiral sculpture is of crisp narrow cords, one submargining the suture, another at the periphery

and two between the periphery and the lower suture, thence continued over the base and anterior end in gradually diminishing strength, except for one just above the neck, which is slightly stronger and forms a weak subangle.

#### *Synonymy*—

- 1914 *Surcula lepidota* Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2 no. 4, p. 117, pl. 1, figs. 23, 24.  
 1919 *Surcula lepidota* Martin, Palaeozool. Kenntnis von Java, p. 74.  
 1931 *Surcula lepidota* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220

### *Turricula plagiaria* (K. Martin, 1931)

(Pl. 209, figs. 7, 8)

**Range**—Nanggulan Beds, Miocene of Kali Puru, Java, Indonesia.

**Remarks**—The author of this species compared it with his *lepidota*. Both are fusiform with a long straight anterior canal, and medially sharply carinate whorls with broadly rounded axial folds, which commence strongly at the periphery and fade out on the base.

Besides being a much larger shell, *plagiaria* differs from *lepidota* in being more narrowly fusiform, with fewer axials, no submargining of the suture, a wider and more steeply descending shoulder area, and less prominent spiral sculpture.

#### *Measurements* (mm.)—

height	width
25.0	—

#### *Synonymy*—

- 1931 *Surcula plagiaria* K. Martin, Moll. Obereocan von Nanggulan. Wetens Meded. Mijnb., No. 18, p. 5, pl. 1, figs. 9, 10.  
 1931 *Surcula plagiaria* Martin, van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

### *Turricula pollii* (Icke & K. Martin, 1907)

(Pl. 206, figs. 5, 6)

**Range**—Nias Island, Sumatra, upper Miocene, Indonesia.

**Remarks**—This is a latiriform shell, stout, broadly fusiform, with a tall spire and a short stout anterior canal. The whorls are prominently angled towards the lower suture and the axial sculpture is of distant strong rounded folds which do not reach the upper suture and rapidly fade out over the base. The axials are strongest, almost knob-like, medially. The spiral sculpture is weak and does not appear to cross the axials medially.

For the present it is accommodated in *Turricula*, *sensu lato*.

*Synonymy*—

- 1907 *Pleurotoma pollii* Icke & Martin, Samml. Geol. Reichs-Mus., Leiden, Ser. 1, vol. 8, p. 228, pl. 14, figs. 8, 8a.  
1931 *Pleurotoma pollii* (Martin-Icke), van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

***Turricula nanggulanensis* (K. Martin, 1931)**

(Pl. 210, fig. 2)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java, Indonesia.

*Remarks*—This species seems to be somewhat related to the *spurius* group. It is characterized by small size, 12 mm. ( $\frac{1}{2}$  inch) in height, narrowly biconical, with strong sculpture of spiral rows of stout tubercles. Noticeable features are the strong subsutural fold and gradually contracted base.

*Measurements* (mm.)—

height	width
12.0	—

*Synonymy*—

- 1931 *Surcula nanggulanensis* Martin, Moll. Obereocan von Nanggulan. Wetens. Meded. Mijnb. Ned.-Indie, vol. 18, p. 6, pl. 1, figs. 12, 12a.  
1931 *Surcula nanggulanensis* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

***Turricula samarangana* (K. Martin, 1884)**

(Pl. 210, fig. 4)

*Range*—Miocene of Java and Pliocene of Sumatra, Indonesia.

*Remarks*—This species is known to me only from Martin's drawing of the dorsal aspect of the type specimen, which is indicated as having a height of about 18 mm. It is characterised by a uniformly moderately strong development of closely gemmate spirals, both over the shoulder slope, and below the peripheral carina to the end of the anterior canal. A single subsutural cord and the peripheral carina, both closely gemmate, are stronger than the other spirals. Although the sinus is not indicated in Martin's illustration the style of sculpture is in accord with that of the *nelliae* - *spurius* group of Turriculids.

*Synonymy*—

- 1884 *Pleurotoma* (*Surcula*) *samarangana* Martin, Tiefbohr. auf. Java, Samml. Reichs-Mus., Leiden, vol. 3, p. 63, pl. 4, fig. 64.

1919 *Surcula samarangana* (Martin), Martin, Palaeozool. Kenntnis von Java, p. 74.

1931 *Surcula samarangana* (Martin), van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

*Records*—JAVA: (Miocene) (type locality); SUMATRA (Pliocene) (Vlerk, 1931).

***Turricula smithi* (K. Martin, 1884)**

(Pl. 210, fig. 3)

*Range*—Lower and upper Miocene of Java, Indonesia.

*Remarks*—Martin compared his species with *Pleurotoma oxytropis* Sowerby, a Central American species of the genus *Polystira*, which has a broadly open sinus with its apex peripheral but Martin assigned his species to *Surcula* = *Turricula*, which has the sinus on the shoulder slope. I have not seen material of this species and Martin's figure does not show the position of the sinus, so for the present it is best retained in *Turricula*, (*sensu lato*), but the clavinid genus *Microdrillia* is a possibility.

The sculpture is very distinctive—two very strong subsutural spiral cords, a broad median space without spirals, and a further three strong cords from the lower third of the whorl height to the lower suture. Rather closely spaced thin axials cross the spiral cords and are continuous over the broad median space on the spire whorls. Spiral cords continue over the base, but the axials there are interstitial and weak to obsolete.

*Measurements* (mm.)—

height
ca 10.5 mm.

*Synonymy*—

- 1884 *Pleurotoma* (*Surcula*) *smithi* K. Martin, Tiefbohr. auf Java, Samml. Reichs-Mus., Leiden, vol. 3, p. 60, pl. 4, fig. 60.  
1919 *Surcula smithi* (Martin), K. Martin, Palaeozool. Kenntnis von Java, p. 74.  
1931 *Surcula smithi* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.  
*Records*—JAVA, bore No. 1, at 616-725 metres, and bore No. 2, at 130 metres (lower and upper Miocene).

***Turricula hillegondae* (K. Martin, 1914)**

(Pl. 210, fig. 1)

*Range*—Nanggulan Beds, upper Eocene of Java, Indonesia.

*Remarks*—From the figure, this species appears to be well placed in *Turricula*, for it bears some resemblance to the *javana* - *nelliae* - *spurius* series. The species must not be confused with *Pleurotoma hillegondae* Martin, 1931, which is a *Comitas*.



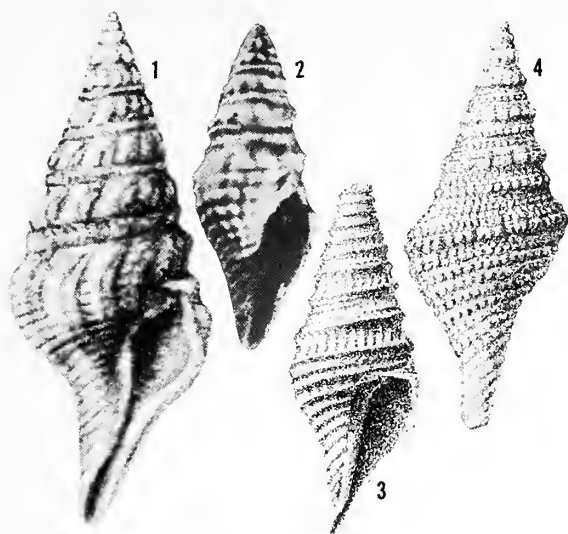


Plate 210. Fig. 1, *Turricula hillegondae* (K. Martin). Nanggulan Miocene of Java. 12.0 mm. (from K. Martin, 1914, pl. 1, fig. 16). Fig. 2, *Turricula nanggulanensis* (K. Martin). Nanggulan Miocene of Java. (from K. Martin, 1931, pl. 1, fig. 12). Fig. 3, *Turricula smithi* (K. Martin). Java, bore at 616-725 metres, Lower and Upper Miocene. 10.5 mm. (from K. Martin, 1884, pl. 4, fig. 60). Fig. 4, *Turricula samarangana* (K. Martin), Miocene of Java. 18.0 mm. (from K. Martin, 1884, pl. 4, fig. 64).

**Description**—Shell small, 12 mm. ( $\frac{1}{2}$  inch) in height, broadly fusiform, with spire and aperture plus canal of about equal height. Whorls rather low, slowly increasing, and with a broadly rounded peripheral bulge towards the lower suture. Subsutural fold strong, followed by a deep narrow shoulder sulcus. Sculpture of strong, flexuous, rounded axials, which are obsolete over the shoulder sulcus but appear again as crenulations on the subsutural fold. The whole surface crossed by incised lines which cut the surface

into moderately wide, flat-topped spiral cords. Base deeply contracted to an anterior canal of moderate length.

#### *Synonymy*—

- 1914 *Surcula hillegondae* Martin, Samml. Geol. Reichs-Mus., Leiden, vol. 2 nos. 4-5, p. 116, pl. 1, figs. 16, 17.  
1931 *Surcula hillegondae* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

#### *Turricula terae* Oostingh, 1938

(Pl. 195, fig. 4)

**Range**—JAVA, South Bantam (Pliocene), Indonesia.

**Remarks**—This species belongs to the *spurius* (“*tuberculata*”) series, despite the sagged appearance of the spire, resultant from the low position of the peripheral carina, which recalls *Makiyamaia*. The anterior canal termination is unnotched and spout-like in *Makiyamaia* but broadly shallowly notched and usually recurved in *Turricula*.

**Description**—Peripheral nodules rather heavy, rounded, and situated on a prominent keel, which is just above the lower suture. Upper suture submargined by a prominent smooth rounded heavy cord. Shoulder area wide, steeply descending and only slightly concave.

#### *Measurements* (mm.)—

height	width
26.5	9.0

#### *Synonymy*—

- 1938 *Turricula* (*Turricula*) *terae* Oostingh, Pal. Dienst. Mijnb. Bandoeng, Java. Gast. 1, p. 25, pl. 1, figs. 17-19.

*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*

## Genus *Comitas* Finlay, 1926

Type: *Surcula oamarutica* Suter, 1917

This genus, formerly thought to be limited to the upper Tertiary of New Zealand and Australia but reaching Recent times in New Zealand, is now shown to have a very considerable Indo-Pacific Recent range as well.

As shown by the Recent *Comitas onokeana vivens* Dell, 1956, from the Chatham Rise, a near relative of the Miocene type of the genus, the operculum is leaf-shaped with a terminal nucleus (Pl. 189, fig. 1) and the radula is of modified wish-bone type, similar to that of most Turricinae. (Pl. 191, fig. 3)

True *Turricula* has a wish-bone type radula also, but the operculum is clavatulid, i.e. with a medio-lateral nucleus.

Once more that very unsatisfactory feature, the operculum, has to be invoked to separate *Turricula* from *Comitas*. Most *Comitas* are distinguishable by their elongately-fusiform shells which have long fold-like axials, very slight submargining of the suture, and a two-whorled smooth protoconch, usually carinate or subcarinate over the last whorl.

Opercular features are not known for fossils, and a large number of Recent species have been described without knowledge of either the protoconch or the operculum. Where such are obviously turriculid but lack the evidence of the operculum or other diagnostic criteria, they are provisionally located, *sensu lato*, in the former genus.

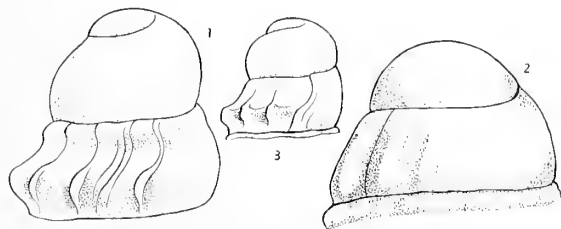


Plate 211. Protoconchs. Fig. 1, *Turricula javana* (Linnaeus), Madras, India. Fig. 2, *Turricula ceylonica* (E. A. Smith). Ceylon. Fig. 3, *Comitas kirai* Powell, new species. Tosa, Japan.

The external features of the animal of *onokeana vivens* are similar to those of *Turricula javana*. Both have stubby cephalic tentacles, ledged on the outer side, with an eye in *javana* but no trace of ledge or eye in *Comitas onokeana vivens*. I am unable to determine if other species of *Comitas* are blind also; *galathea*, the only other species examined, although from shallower water, has well developed eyes.

The only animal of *onokeana vivens* available, a male, has a large extremely long penis, tapered gradually to a sharp extremity. By comparison the male organ in *Turris babylonica* is moderately long, broad but laterally compressed, leaf-shaped, with a more rapidly tapered extremity, and the cephalic tentacles are long and slender, and strongly ledged, with very distinct eyes.

The genus *Comitas* has a very wide distribution in the Indo-Pacific, ranging from South Africa to Japan and southward through Australian waters to southern New Zealand. In general it is a cold water genus, and it must be noted that the equatorial occurrences are all from deep water basins which receive a strong inflow of cold water that originates in the Antarctic.

Fossil occurrences of the genus date back to the upper Eocene of South Australia, probably the Eocene of Pakistan, and the Otaian, lower Miocene of New Zealand.

## Synonymy—

- 1926 *Comitas* Finlay, Trans. New Zealand Inst., vol. 56, p. 251. Type: by original designation: *Surcula oamarutica* Suter, 1917 (= *Drillia fusiformis* Hutton, 1877).  
1942 *Carinacomitas* Powell (subgenus of *Comitas*), Bull. no. 2, Auck. Inst. Mus., p. 60. Type: by original designation: *Pleurotoma clarae* Tenison-Woods, 1880.

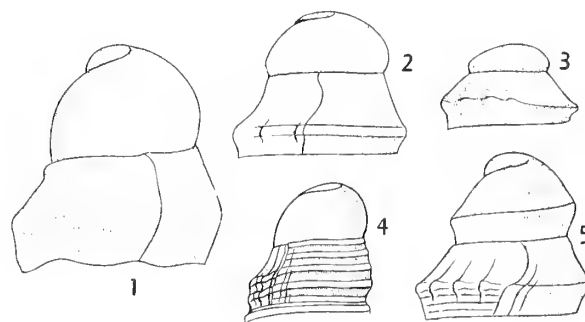


Plate 212. Protoconchs. Fig. 1, *Comitas fusiformis* (Hutton). New Zealand, Upper Oligocene. Fig. 2, *Comitas (Carinacomitas) clarae* (Tenison Woods). Victoria, Miocene. Fig. 3, *Anticomitas vivens* Powell. New Zealand, Recent. Fig. 4, *Antimelatoma buehanani* maorum (E. A. Smith). New Zealand, Recent. Fig. 5, *Paracomitas castlecliffensis* (Marshall & Murdoch). New Zealand, Pleistocene.



### Key to New Zealand *Comitas*

#### A. Shell narrowly fusiform

1. Axials rounded, fold-like, extending from above shoulder angle to just below lower suture

Shoulder at about two-thirds whorl height

Spiral sculpture dense, with wider-spaced stronger threads

Axials 7 per whorl, broad, vertical

..... *latiaxialis* (Marshall)

Spiral sculpture of strong rounded cords

Axials 11 per whorl, broad, vertical

..... *trailli* (Hutton)

Spiral sculpture of numerous weak cords and intermediate threads

Axials 12-13 per whorl, narrow, oblique

..... *onokeana* King

Shoulder at about two-thirds whorl height

Spiral sculpture, few broad cords, linear interspaces

..... *terrissae* Vella

Shoulder just above middle whorl height

Axials 10-12 per whorl, broad, slightly oblique

Spirals moderate, with intermediate threads,

30-60 mm ..... *fusiformis* (Hutton)

Spirals strong, sharply raised, 25 mm

..... *kaipara* Laws

Shoulder at about one third whorl height

Axials about 12 per whorl, very oblique

..... *imperfecta* King

2. Axials narrow, obliquely flexuous;

Shoulder above middle ..... *solitaria* (King)

3. Axials weak, confined to periphery

Spiral sculpture of strong crisp cords

Axials 13 per whorl ..... *allani* Powell

4. Axials blunt knobs occupying one third whorl height

Base with regular spiral threads

Axials 9-10 per whorl. Shell height 25 mm

..... *abnormis* King

Axials 11-12 per whorl. Shell height 19 mm

..... *declivis* Powell

Base with two prominent cords as well as weak spirals

Axials 12-13 per whorl; longer than wide

..... *bilix* Marwick

#### B. Shell broadly fusiform

Axials blunt, broadly rounded, not prominent, peripheral

Shoulder deeply concave ..... *latescens* (Hutton)

### New Zealand *Comitas*

The type species of the genus *Comitas* is from the lower Miocene of New Zealand. The genus also extends to the Recent fauna in that area, has a similar range in Australia, and is now recognised as a wide-ranging constituent of the Indo-Pacific fauna extending from South Africa to Japan. Following is a list of the New Zealand Tertiary and Recent species.

#### *Comitas abnormis* King, 1933

*Locality*—Mouth of Putangirua Creek, Palliser Bay (Tongaporutuan, Hurupi series, upper Miocene). The type is in the New Zealand Geological Survey, Wellington.

##### *Synonymy*—

1933 *Comitas abnormis* King, Trans. N. Z. Inst., vol. 63, p. 348, pl. 37, f. 17.

#### *Comitas allani* Powell, 1942

(Pl. 222, fig. 3)

*Locality*—N.Z.G.S. loc. 1543, mudstone and argillaceous sandstone beds, Mangawhero Stream, Taramarama (S. W.) S. D., Wairoa (Opoitian, lower Pliocene). The type is in the Auckland Museum.

##### *Synonymy*—

1942 *Comitas allani* Powell, Bull. No. 2, Auck. Inst. Mus., p. 59, pl. 10, fig. 6.

#### *Comitas bilix* Marwick, 1931

*Locality*—N. Z. G. S. loc. 1290, Gisborne (Ormond series, Opoitian?, lower Pliocene). The type is in the New Zealand Geological Survey, Wellington.

##### *Synonymy*—

1931 *Comitas bilix* Marwick, N. Z. Geol. Surv. Pal. Bull. 13, p. 137, pl. 15, fig. 286.

#### *Comitas declivis* Powell, 1931

*Locality*—Waihi Beach, Hawera (Waitotaran, lower Pliocene). The type is in the Auckland Museum.

##### *Synonymy*—

1931 *Comitas declivis* Powell, Rec. Auck. Inst. Mus., vol. 1, p. 107, pl. 14, fig. 41.

### *Comitas fusiformis* (Hutton, 1877)

(Pl. 216, fig. 1; pl. 212, fig. 1)

*Localities*—Mt. Harris, South Canterbury (type of *fusiformis*); "Oamaru" = ? Rifle Butts (type of *oamarutica*) (Awamoan, lower Miocene). Types; Otago Museum, Dunedin (*fusiformis*); New Zealand Geological Survey, Wellington (*oamarutica*).

##### *Synonymy*—

1873 *Pleurotoma trailli* Hutton, Cat. Tert. Moll. N. Z., p. 4 (June), non Cat. Mar. Moll. N. Z. p. 11 (May).

1877 *Drillia fusiformis* Hutton, Trans. N. Z. Inst., vol. 9, p. 595 (non *Pleurotoma fusiformis* Sowerby, 1823) (not homonyms).

1914 *Surcula huttoni* Suter, N. Z. Geol. Surv. Pal. Bull. 2, p. 28 (nom. nov. for *Pl. trailli* Hutton, 1873 (June) (unnecessary)).

1917 *Surcula oamarutica* Suter, N. Z. Geol. Surv. Pal. Bull. 5, p. 51, pl. 6, figs. 9, 10.

1942 *Comitas fusiformis* (Hutton), Powell, Bull. 2, Auck. Inst. Mus., p. 58.

#### *Comitas imperfecta* King, 1933

*Locality*—Marls 1 mi. below Turanganui Gorge, S. Wairarapa (Hurupi series, Tongaporutuan, upper Miocene). The type is in the New Zealand Geological Survey, Wellington.

##### *Synonymy*—

1933 *Comitas imperfecta* King, Trans. N. Z. Inst., vol. 63, p. 349, pl. 35, fig. 2.

#### *Comitas kaupara* Laws, 1939

*Locality*—Pakaurangi Point, Kaipara (Otaian, lower Miocene). The type is in the New Zealand Geological Survey, Wellington.

##### *Synonymy*—

1939 *Comitas kaupara* Laws, Trans. Roy. Soc. N. Z., vol. 68, p. 497, pl. 65, fig. 44.

#### *Comitas latescens* (Hutton, 1873)

*Locality*—Mount Brown, North Canterbury (lower Miocene). The type is in the New Zealand Geological Survey, Wellington.

##### *Synonymy*—

1873 *Pleurotoma latescens* Hutton, Cat. Tert. Moll. N. Z., p. 4.

#### *Comitas latiaxialis* (Marshall, 1918)

*Locality*—Pakaurangi Point, Kaipara (Otaian, lower Miocene). The type is in the New Zealand Geological Survey, Wellington.

##### *Synonymy*—

1918 *Surcula latiaxialis* Marshall, Trans. N. Z. Inst., vol. 50, p. 267, pl. 20, fig. 3.

***Comitas onokeana subspecies  
onokeana* King, 1933**

*Locality*—Cliffs E. of Lake Ferry, Palliser Bay, Wellington (Waitotaran, Pliocene—Nukumaruan, lower Pleistocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1933 *Comitas onokeana* King, Trans. N. Z. Inst., vol. 63, p. 348, pl. 37, fig. 16.

*Remarks*—See New Zealand Recent subspecies, following.

***Comitas onokeana subspecies  
vivens* Dell, 1956**

(Pl. 216, fig. 2)

*Remarks*—Dell considered that *vivens* is extremely close to *onokeana*, differing from that Pleistocene species only in the lack of spiral sculpture on the shoulder.

The radula of *vivens* is described by Dell as “of the ‘wish-bone’ type with no centrals.” These marginals as shown by Dell’s illustration (fig. 259) have two components. Collectively the marginals are wish-bone shaped but the basal extensions of each tooth are severed above and behind the more massive inner member.

*Locality*—New Zealand, Chatham Rise, 260 fathoms. The type is in the Dominion Museum, Wellington.

*Synonymy*—

1956 *Comitas onokeana vivens* Dell, Dominion Mus. Bull., vol. 18, p. 131, fig. 171.

**?*Comitas solitaria* (King, 1933)**

*Locality*—Cliffs E. of Lake Ferry, Palliser Bay, Wellington (Waitotaran, Pliocene—Nukumaruan, lower Pleistocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1933 *Insolentia solitaria* King, Trans. N. Z. Inst., vol. 63, p. 350, pl. 36, fig. 11.

***Comitas terrisae* Vella, 1954**

*Locality*—N. Z. G. S. loc. N165/507, Bell’s Creek, S. E. Wairarapa (middle Tongaporutuan, upper Miocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1954 *Comitas terrisae* Vella, Trans. Roy. Soc. N. Z., vol. 81 no. 4, p. 548, pl. 27, figs. 24, 25.

***Comitas trailli* (Hutton, 1873)**

*Localities*—Stewart Island, 24 fathoms (*trailli*); Foveaux Strait, 15 fathoms (*verrucosa*). The type of *trailli* is in the Dominion Museum, Wellington, and that of *verrucosa* in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1873 *Pleurotoma trailli* Hutton, Cat. Marine Moll. N. Z., p. 11.

1899 *Surcula verrucosa* Suter, Trans. N. Z. Inst., vol. 31, p. 70, pl. 3, figs. 1, 1a.

1942 *Comitas trailli* (Hutton), Powell, Bull. 2, Auck. Inst. Mus., p. 60.



### Key to Australian Tertiary species of *Comitas*

- A. Whorls spirally sulcate, very slightly angled
  - Axials obsolete . . . . . *salebrosa* (Harris)
- B. Whorls spirally ribbed and axially costate
  - Spiral primaries 2-3 on spire whorls
    - Axials 9 per whorl . . . . . *wynyardensis* (Pritchard)
  - Spiral primaries 4-5 on spire whorls
    - Axials 6-7 per whorl . . . . . *pseudoclarae* Powell
    - Axials 9 per whorl . . . . . *crenularoides* (Pritchard)
    - Axials 10 per whorl . . . . . *torquayensis* Powell

### Australian Tertiary *Comitas*

#### *Comitas crenularoides* (Pritchard, 1896)

*Locality*—Table Cape, Tasmania (Janjukian, lower Miocene).

#### *Synonymy*—

1896 *Drillia crenularoides* Pritchard, Proc. Roy. Soc. Victoria, vol. 8 (n. s.), p. 110, pl. 3, figs. 6, 7.

1944 *Comitas crenularoides* (Pritchard), Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 17.

#### *Comitas pseudoclarae* Powell, 1944

*Locality*—Torquay, Victoria (lower Miocene). The type is in the Auckland Museum.

#### *Synonymy*—

1944 *Comitas pseudoclarae* Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 18, pl. 1, fig. 6.

#### *Comitas salebrosa* (Harris, 1897)

*Locality*—"Hobson's Bay" = Balcombe Bay, Victoria (Balcombian, middle Miocene). The type is in the British Museum (Natural History).

#### *Synonymy*—

1897 *Pleurotoma salebrosa* Harris, Cat. Tertiary Mollusca in Brit. Mus., Pt. 1, p. 42, pl. 3, figs. 3 a-d.

1944 *Comitas salebrosa* (Harris), Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 18.

#### *Comitas torquayensis* Powell, 1944

*Locality*—Torquay, Victoria, lower blue clays

(lower Miocene). The type is in the Auckland Museum.

#### *Synonymy*—

1944 *Comitas torquayensis* Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 17, pl. 3, fig. 9.

#### *Comitas wynyardensis* (Pritchard, 1896)

*Locality*—Table Cape, Tasmania (Janjukian, lower Miocene).

#### *Synonymy*—

1896 *Pleurotoma wynyardensis* Pritchard, Proc. Roy. Soc. Victoria, vol. 8 (n. s.), p. 109, Pl. 2, f. 12, 13.

1944 *Comitas wynyardensis* (Pritchard), Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 17.

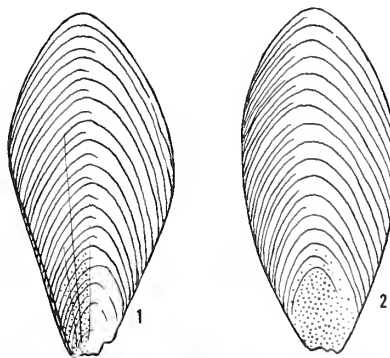


Plate 213. Opercula. Fig. 1, *Comitas thisbe diomedea* Powell, new subspecies. Fig. 2, *C. palawanica* Powell, new species.

**Indo-Pacific**  
**Key to Species of *Comitas***

A rough guide to the more easily diagnosed species, mainly Recent. Owing to subtle combinations of characters, a complete key is not considered practicable. For species not included in the key, compare the remarks under each species in the text.

- A. Shell large, solid, elongate-fusiform (65-95 mm.)  
 Axials stout vertical folds  
   Spiral lirae distinct.....*fusiformis* (Hutton)  
   Spiral lirae obsolete  
     Axials reaching lower suture....*kaderlyi* (Lischke)  
     Axials not reaching lower suture  
       .....*murrawolga* (Garrard)  
 Axials stout oblique folds  
   Spiral lirae very fine.....*stolida* (Hinds)  
   Spiral lirae subobsolete.....*onokeana vivens* Dell  
 Axials weak, resolving into a peripheral carina  
   .....*galathea* Powell
- B. Shell large, thin, ovate-fusiform (42-106 mm.)  
 Body-whorl long, slowly tapered  
   Axials slightly oblique folds.....*sibogae* (Schepman)  
   Axials obsolete.....*kuroharai* (Oyama)  
 Body-whorl capacious  
   Axials short, on median angulation  
     .....*symploites* (W. -M. & A.)  
   Axials and angulation subobsolete  
     .....*symploites subcorpulenta* (Smith)  
   Axials strong very oblique folds *chuni* (von Martens)  
   Axials absent, whorls rounded, spirals distinct  
     .....*rotundata* (Watson)
- C. Shell moderately large, solid, fusiform (42-62 mm.)  
 Spire tall, base truncated  
   Shoulder slope strongly spirally lirate *eurina* (Smith)  
   Shoulder slope weakly spirally lirate *luzonica* Powell  
   Shoulder slope bulging.....*margaritae* (Smith)  
   Shoulder slope smooth  
     Axials few, very strong nodes.....*arcana* (Smith)  
     Axials long, very oblique.....*melvilli* (Schepman)  
 Spire not tall, shell relatively wide  
   Axials narrow, long, very oblique...*thisbe* (Smith)  
   Axials short, stout, oblique *thisbe diomedea* Powell

## D. Shell elongate-fusiform, of light build (12-55 mm.)

Suture not margined

Colour zoned

Axials long ..... *kamakurana* (Pilsbry)

Axials two rows of peripheral gemmules

..... *lurida* (Ad. & Reeve)

Axials a single peripheral series

..... *albicincta* (Ad. & Rve)

Colour pattern absent

Whorls carinate throughout

Axials subobsolete on later whorls . . *kirai* Powell

Axials prominent throughout

Axials pointed tubercles ..... *suluensis* Powell

Axials long oblique plicae

Basal spirals few, strong

..... *pagodaeformis* (Schepman)

Basal spirals many, weaker

..... *breviplicata* Smith

Whorls nodulose above, obsolete below

Body-whorl smooth

Nodulose whorls 4 ..... *aequatorialis* (Thiele)

Body-whorl with plain peripheral carina

Nodulose whorls 6-7

Body-whorl narrow ..... *undosa* (Schepman)

Body-whorl inflated

..... *aequatorialis palawanica* Powell

Whorls with long very oblique axials

..... *opulenta* (Thiele)

Whorls with small peripheral nodes

..... *variabilis* (Schepman)

Suture gemmate or plicate margined (16-24 mm.)

Suture gemmate

Peripheral axials oblique . . *exstructa* (von Martens)Peripheral nodes laterally elongate . . *erica* (Thiele)

Suture crenulate

Peripheral nodes small, pointed

..... *subsuturalis* (von Martens)

Peripheral nodes large, rounded

..... *obtusigemmata* (Schepman)



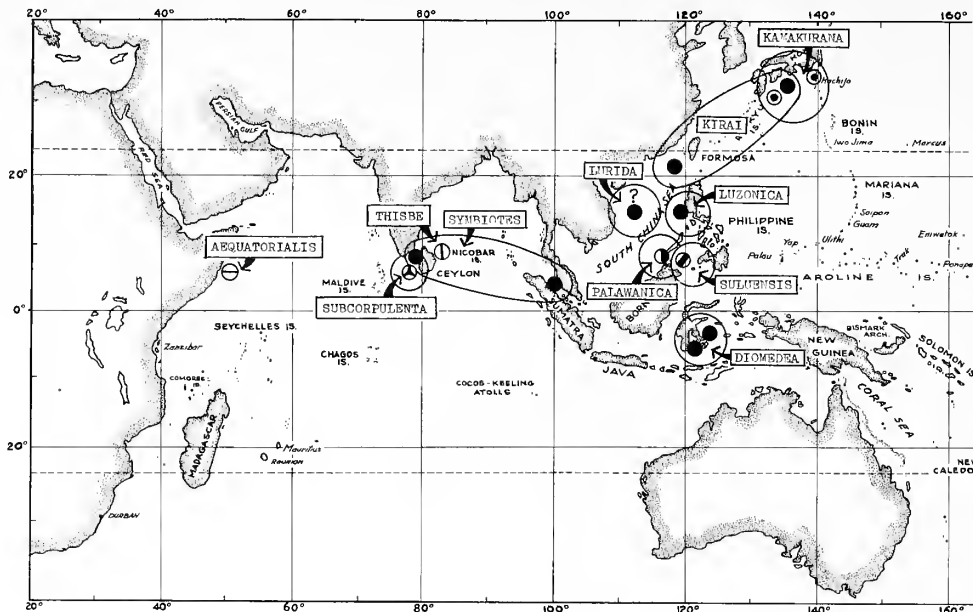


Plate 214. Geographical distribution of some deep-water, light-build species and subspecies of *Comitas* of the *symbiotes* and *lurida* groups- *symbiotes* (Wood-Mason & Alcock) and subspecies *subcorpulenta* (E. A. Smith), *aequatorialis* (Thiele) and subspecies *palawanica* Powell new subspecies,

*thisbe* (E. A. Smith) and subspecies *diomedea* Powell new subspecies, *lurida* (Adams & Reeve), *kamakurana* (Pilsbry), *kirata* Powell new species, *luzonica* Powell new species and *suluensis* Powell new species.

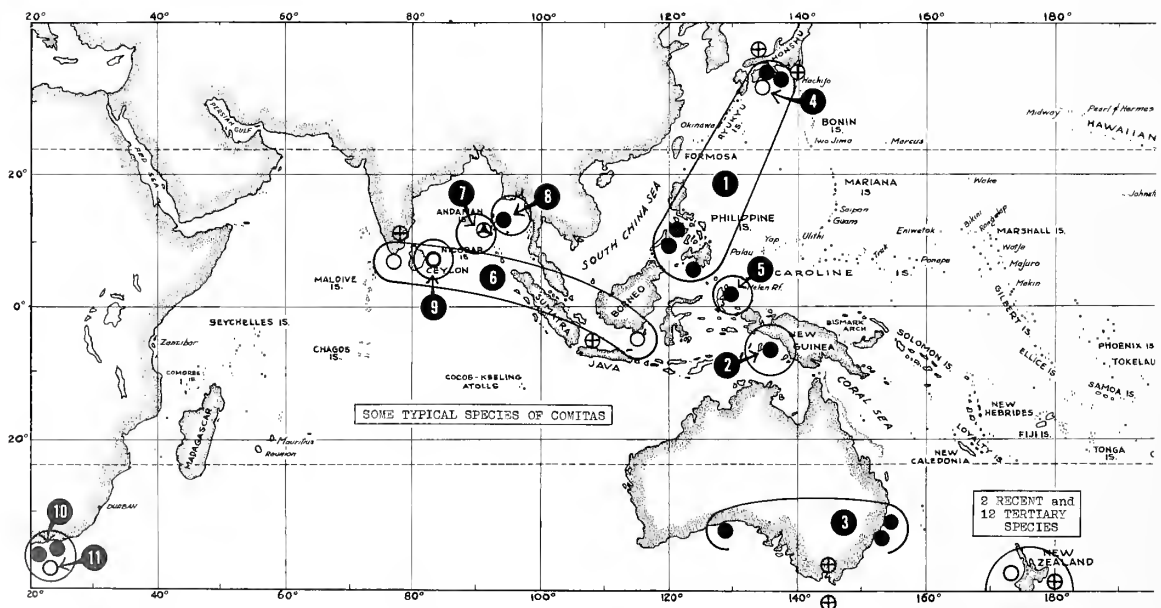


Plate 215. Geographical distribution of some typical species of *Comitas*. 1. *Comitas kaderlyi* (Lischke). 2. *C. galatheae* Powell new species. 3. *C. murawolga* (Garrard). 4. *C. kuroharai* (Oyama). 5. *C. pagodaformis* (Schepman). 6. *C. curina* (E. A. Smith). 7. *C. breviplicata* (E. A. Smith). 8. *C. margaritae* (E. A. Smith). 9. *C. thisbe* (E. A. Smith). 10. *C. stolidi*

(Hinds). 11. *C. anteridion* (Watson). Tertiary species are marked by a cross within a circle. New Zealand has 12 Tertiary species and 2 Recent species. Australia and Tasmania have 5 species, 3 of which are Recent. There are Tertiary species also in Japan and southern India.

## Recent Indo-Pacific Species

*Comitas kaderlyi* (Lischke, 1872)

(Pl. 192, fig. 12-14; pl. 216, fig. 3)

*Range*—Japan to Philippines.

*Remarks*—This is a well-known member of the Japanese shelf-fauna characterized by its large size, fusiform shape, strong fold like axials and buff to light-brown ground colour, faintly banded in darker brown.

The Baracay Island specimen shows faintly the characteristic colour zoning but those from the Japanese station 3698 as well as those from the Philippine stations 5494 and 5429 are entirely lacking in colour pattern. Also, there is a slight tendency towards more oblique ribbing and a wider sinus in all the deep-water Philippine material, with the exception of the Panay specimen, station 5429, which is inseparable from Japanese examples.

There is insufficient material to determine if a bathymetric subspecies is represented or if the slight variations mentioned above are admissible within the normal range of the species.

*Description*—Adult shell large, 69-94 mm. ( $2\frac{3}{4}$ - $3\frac{3}{4}$  inches) in height, fusiform with turretted spire and moderately long anterior canal. Height of spire about equal to height of aperture plus canal. Whorls eleven plus a small bluntly rounded protoconch of  $1\frac{1}{2}$  smooth whorls followed by a half whorl of closely spaced brepheic axials. Spire-whorls with a broad steeply descending concave shoulder area which extends from the unmarginated suture to a somewhat rounded but distinct angulation at a little above middle-whorl height. From the angulation to the lower suture there are strong slightly protractively oblique axial folds, about twelve per whorl. These fade out on the upper base at a little below the level of the top of the aperture. The whole surface is densely spirally lirate. Sinus sigmoid, deep but rather narrowly rounded at its apex which is towards the lower extremity of the shoulder area, then produced forwards in the great arcuate sweep of the outer lip, which is thin edged. Colour buff to light-brown, zoned with reddish-brown; one zone occupies the shoulder area, another the upper base and a third covers the anterior fasciole. Variations include one in which neither the shoulder area nor the anterior fasciole is zoned but the shell is two banded, one coinciding with the axials and the

other situated on the lower base. Deep-water examples are usually devoid of colour pattern. Operculum leaf-shaped with a terminal nucleus (Pl. 189, fig. 3).

*Measurements* (mm.)—

height	width	
94.0	31.5	Off Palawan, 766 fathoms (USNM)
88.5	29.5	Off Mindanao, 678 fathoms (USNM)
74.0	21.0	Tosa, Japan, 70 fathoms
70.0	21.0	Tosa, Japan, 70 fathoms
69.5	21.0	Tosa, Japan, 70 fathoms

*Synonymy*—

- 1872 *Pleurotoma kaderlyi* Lischke, Malak. Blatt., vol. 19, p. 100 (not figured).  
 1884 *Surcula kaderlyi* (Lischke), Tryon, Man. of Conch., vol. 6, p. 239, pl. 6, fig. 75.  
 1895 *Surcula kaderlyi* (sic) (Lischke), Pilsbry, Cat. Marine Moll. Japan, F. Stearns, Detroit, p. 19.  
 1936 *Turricula kaderlyi* (Lischke), Hirase, A Collection of Jap. Shells, pl. 115, fig. 7.

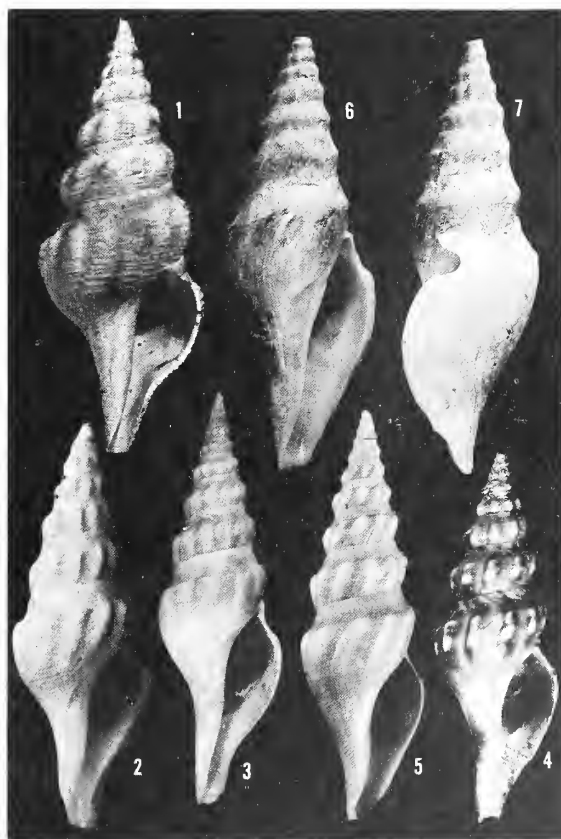


Plate 216. Fig. 1, *Comitas fusiformis* (Hutton). New Zealand, Rifle Butts, Oamaru, Awamoan Miocene. 60.0 mm. (type of *Comitas*). Fig. 2, *Comitas onokeana vivens* Dell. 1956, New Zealand, Chatham Rise, 260 fathoms. 41.0 mm. Fig. 3, *Comitas kaderlyi* (Lischke). Tosa, Japan. 74.0 mm. Fig. 4, *Comitas murrayvolga* (Garrard). Holotype, New South Wales, 75 fathoms off Broken Bay, 57.0 mm. Fig. 5, *Comitas stolidus* (Hinds). False Bay, South Africa, 30 fathoms. 55.0 mm. Figs. 6, 7, *Comitas galathea*, *Powell new species*. Holotype, West New Guinea, off Aru Islands, 352 metres. 94 mm.

1954 *Turricula kaderleyi* (sic) (Lischke), Kira, Coloured Illust. Shells of Japan, pl. 35, f. 15

*Records*—JAPAN: off Tosa, 70 fathoms; Wakayama; Enoshima and Kii (ANSP); Hondo, 197 fathoms (Albatross Sta. 5091); off Honshu, 153 fathoms (Albatross Sta. 3698) (USNM). PHILIPPINES: off Dinata Point, Mindanao, 678 fathoms (Albatross Sta. 5494); off Panagtaran Point, East Palawan, 766 fathoms, green mud (Albatross Sta. 5429); West of Baracay Island, Panay, Philippines, 312 fathoms, grey mud and Globigerina (Albatross Sta. 5259) (USNM).

### *Comitas galathea* new species Powell

(Pl. 216, figs. 6, 7)

*Range*—Off Aru Islands, Indonesia in 352 metres.

*Remarks*—Only a single specimen of this shell is known. Allowing for probable gerontic tendencies, the Aru Islands shell appears to stand outside the range of variation acceptable for *kaderlyi*. When compared with *kaderlyi* of equal size the Aru shell is shown to have a longer and narrower aperture, a more gradually tapered body-whorl, an almost straight columella + parietal wall profile, medially carinate late whorls accompanied by subobsolescence of the axial sculpture, and a deep U-shaped posterior sinus, which has a much wider, more broadly rounded apex, occupying the lower two-thirds of the shoulder slope. Confirmation that the Aru shell is not merely a gerontic *kaderlyi* is furnished by the operculum, which is lanceolate in *galathea* but broadly leaf-shaped in *kaderlyi*.

*Description*—Shell large and very solid, ca 97 mm. (3¾ inches) in height, fusiform, with tall turreted spire and long, rather narrow body-whorl, gradually tapered to a stout, almost straight, widely open, moderately long, unnotched anterior canal. Whorls 7+, protoconch and early spire whorls eroded away. Spire whorls medially angulated, early ones with broadly rounded oblique axial folds, abruptly stopped at the angulation, about ten per whorl. The axial folds become subobsolete from the commencement of the penultimate whorl, after which they are represented by strongly protractively arcuate, rather irregular folds, which commence strongly at the peripheral angle but rapidly fade out over the base. Aperture long and narrow; inner lip almost straight in profile; outer lip thin edged; posterior sinus deep, U-shaped, with a broadly rounded apex and occupying almost the lower two-thirds of the steeply descending, rather straight, shoulder slope; lower edge at the peripheral angulation. Lower part of outer lip produced

forwards in a broad sweeping arc. Colour dull white, interior of aperture and parietal callus porcellaneous-white. Surface of shell crowded with fine spiral threads. Operculum lanceolate, tapered below to a long straight gradually tapered point (30 × 8 mm.) (Pl. 189, fig. 4); that of *kaderlyi* is normal leaf-shaped and proportionately much broader (16 × 7 mm, in a shell 74 mm. in height). Animal with cephalic tentacles broad-based and short, each with a prominent eye, stepped on the outer edge about one third way down from the blunt tip. Penis flattened, very long (ca 45 mm.), gradually tapered to a fine point.

#### *Measurements (mm.)*—

height	width
94 +	31.0

*Types*—The unique holotype is in the University Museum, Copenhagen (collected Th. Mortensen, May 7, 1922). The type locality is 352 metres, 5° 46' S., 132° 49' 35" E., off the Aru Islands, eastern Indonesia.

### *Comitas murrawolga* (Garrard, 1961)

(Pl. 216, fig. 4)

*Range*—Eastern to South Western Australia, 40-100 fathoms.

*Remarks*—Too few examples of Garrard's species are known to judge its true relationship with *kaderlyi*. It is certainly very close to *kaderlyi* and may eventually prove to be just a regional subspecies of it. From *kaderlyi* the Australian shell differs only in having 10-11 instead of 11-12 axials per whorl, and a narrower less sloping shoulder. Also the axials tend to be shorter, becoming obsolete before the lower suture is reached.

The typical coloration is "white, flamed with dark chestnut, a white patch present in centre and on top of each nodule, and a white band encircles body-whorl midway between nodules and anterior end of shell; interior of aperture follows general coloration."

A single uniformly creamy-white shell in the Australian Museum from 100 fathoms, 20 miles west of Eucla, South Australia has more upright and slightly longer axials. When more material is available this form may prove to be separable.

#### *Measurements (mm.)*—

height	width	
57.0	19.0	(holotype)
52.5	17.0	40-50 fathoms off Newcastle
52.0	16.5	100 fathoms off Eucla
48.5	16.0	(paratype)



*Synonymy*—

1961 *Turricula murrawolga* Garrard, Journ. Malac. Soc. Aust., vol. 5, p. 33, pl. 1, fig. 8.

*Types*—Holotype and paratype in the Australian Museum, Sydney.

*Records*—AUSTRALIA: 75 fathoms off Broken Bay, New South Wales (type locality); 40-45 fathoms off Newcastle, New South Wales (Aust. Mus.); 100 fathoms, 20 miles west of Eucla, South Australia (Aust. Mus.).

**?Comitas saldanhae (Barnard, 1958)**

(Pl. 205, fig. 1)

*Range*—West coast of South Africa and South West Africa, 55-311 metres.

*Remarks*—This species, described as a *Turris*, is certainly not that genus, but a turriculid, that is if the broadly arcuate sinus occupying the shoulder slope, as indicated in Barnard's line drawing of type, can be taken as correct. Barnard's material consisted of three dead shells and one live taken, but all are minus the nuclear whorls.

Both the operculum, which is leaf-shaped with a terminal nucleus, and the radula of modified "wishbone" type, justify the provisional location of the species in the *Comitas* series.

The species is of course not Indo-Pacific, but it is of interest in respect to the distributional pattern of the wide-ranging *Comitas*.

*Measurements (mm.)*—

height	width
46 +	15.0
34 +	12.0

*Synonymy*—

1958 *Turris saldanhae* Barnard, Annals S. African Mus., vol. 44, p. 109, figs. 3f (radula), 7.

*Types*—The holotype and supplementary material is in the South African Museum, Cape Town.

*Records*—SOUTH AFRICA: off Baboon Point, Saldanha Bay, 31 fathoms (type locality); SOUTH WEST AFRICA: off Luderitzbucht, 55, 183 and 311 metres.

**Comitas stolidia (Hinds, 1843)**

(Pl. 216, fig. 5)

*Range*—South Africa, 30-73 fathoms.

*Remarks*—This fine species conforms with typical *Comitas* in general shell facies, including the bold simple oblique fold-like axial ribs, stopped over the shallowly concave shoulder area, the moderately deep sinus with a narrowly rounded apex, a leaf-shaped operculum with a terminal nucleus, a radula of modified "wishbone" shaped marginals only, and a smooth papillate protoconch of 2½ whorls.

Barnard (1958 l.c.) mentioned a slender form with the ribs consequently closer together so that 5 instead of 4 are visible in face view. He also considered *stolidia* to be closely similar to *Plenrotoma* (*Surcula*) *margaritae* E. A. Smith, 1904, from off the Andaman Islands in 405 fathoms.

*Description*—Shell large, robust, 29-68 mm. (1-2¾ inches) in height, elongate-fusiform with tall spire, narrow aperture and moderately long almost straight anterior canal. Height of spire almost 1½ times height of aperture plus canal. Whorls bluntly but distinctly angled at about middle whorl height. Shoulder slope slightly concave, devoid of axials, which commence strongly at the peripheral angle, are protractively oblique and extend to the lower suture, but fade out at about the middle of the base, 11-12 per whorl (narrow form), increasing to 13-14 on later whorls (according to Barnard). There is no sub-sutural fold or margining. The whole surface crowded with fine spiral striations. Whorls 9-10 plus a high smooth protoconch of 2½ whorls (Barnard). Sinus moderately deep, with a narrowly rounded apex just below the middle of the shoulder slope. Colour uniformly cream, with a thin buff periostracum. Operculum leaf-shaped with a terminal nucleus (Pl. 189, fig. 2). Radula "with 38 rows, no central plate, lateral (= marginal) with wing-like appendage" (Barnard), i.e. the basal extensions of each tooth are severed above and behind the more massive inner member, as in the New Zealand *onokeana vivens* Dell, 1956.

*Measurements (mm.)*—

height	width	
68.0	20.0	(Barnard; broad form)
55.0	16.0	(False Bay; slender form)
52.0	15.0	(Barnard; slender form)
29.0	—	(holotype; broad form)

*Synonymy*—

1843 *Pleurotoma stolidia* Hinds, Proc. Zool. Soc., London, p. 37.

1843 *Pleurotoma stolidia* Hinds, Reeve, Conch. Iconica, vol. 1, pl. 18, fig. 152.

1844 *Pleurotoma stolidia* Hinds, Zool. Voy. Sulphur. vol. 2, p. 15, pl. 5, fig. 5.

1958 *Turris stolidia* (Hinds), Barnard, Ann. S. African Mus., vol. 44, p. 101, fig. 3e (radula).

*Types*—The holotype (broad form) is in the British Museum (Natural History).

*Records*—SOUTH AFRICA: Agulhas Bank, 43 fathoms (type locality); Glendower Beacon (Port Alfred area) to False Bay, 32-73 fathoms; St. Sebastian Bay, 40 fathoms (broad form); off Cape Hangklip, 73 fathoms (Barnard, 1958); False Bay, 30 fathoms, fine sand (Th. Mortensen, 19th. Dec. 1929, Zool. Mus. Copenhagen) (narrow form).

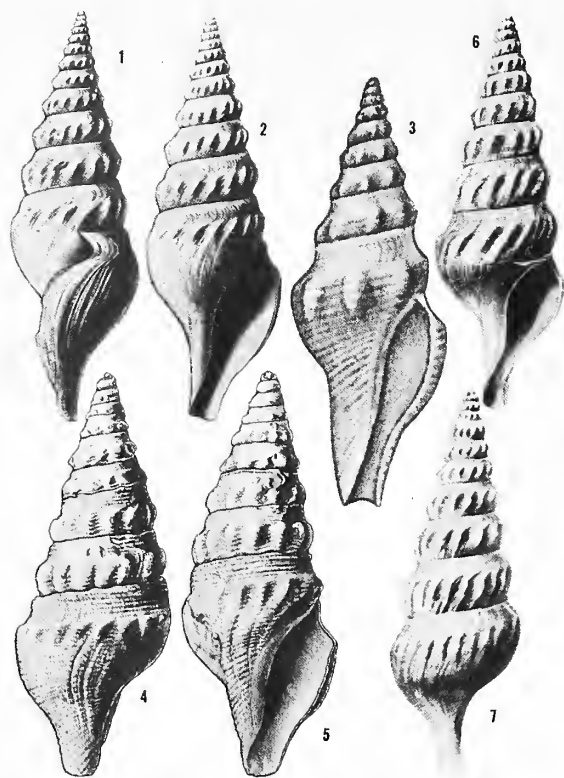


Plate 217. Figs. 1, 2, *Comitas margaritae* (E. A. Smith). Off Andaman Islands, 405 fathoms. 60.0 mm. (from Annandale & Stewart, 1909, pl. 14, figs. 2, 2a). Fig. 3, *Comitas malayana* (Thiele). Padang, Sumatra. 13.5 mm. (from Thiele, 1925, pl. 24, fig. 19). Figs. 4, 5, *Comitas eurina* (E. A. Smith). Off South India, 430 fathoms. 44.0 mm. (from Annandale & Stewart, 1909, pl. 9, figs. 4, 4a). Figs. 6, 7, *Comitas melvilli* (Schepman). Banda Sea, 560 metres. 62.0 mm. (from Schepman, 1913, pl. 27, figs. 7a, b).

### *Comitas eurina* (E. A. Smith, 1899)

(Pl. 217, figs. 4, 5)

*Range*—Off South India, 430 fathoms.

*Remarks*—This species is notable for strong spiral sculpture continuing over the entire shoulder slope, an area usually either devoid of spirals or with such sculpture, there considerably reduced.

Although both the protoconch and the operculum are unknown, the style of axial sculpture, and oblique folds stopped at the shoulder, suggest *Comitas*.

*Description*—Shell moderately large, fusiform, 44 mm. ( $1\frac{3}{4}$  inches), with tall spire and relatively short unnotched anterior canal. Spire  $1\frac{1}{3}$  times height of aperture plus canal. Whorls probably 9–10, but the apical whorls are eroded in the type

specimen. Whorls with a prominent shoulder area, at first bulging subsuturally then abruptly concave below, upon reaching the broadly rounded axially plicate peripheral angulation, which occupies a little more than half the whorl height. Axial folds about 12–14 per whorl, nearly vertical on the spire whorls but becoming protractively oblique over the body-whorl; they commence abruptly at the lower extremity of the shoulder sulcus and fade out at the lower suture. The whole of the surface is covered with rather strong evenly developed spiral threads, 5–6 over the shoulder sulcus. The sinus is broadly rounded, of moderate depth and occupies the whole of the shoulder sulcus. The anterior end is rather stout, the canal short, straight and unnotched. Colour white, covered by a thin yellowish periostracum.

The specimen recorded below, from 890 fathoms off Borneo, has a slightly longer canal than that of the holotype and this may represent the norm for the species. The figure of the holotype indicates a body-whorl injury that could have caused an abnormality in respect to the length of the canal. This discrepancy, however, cannot be evaluated upon the evidence of only two specimens.

#### *Measurements (mm.)—*

height	width	
44.0	15.0	off S. India, 430 fathoms (holotype)
27.0	10.5	off Borneo, 890 fathoms

#### *Synonymy—*

1899 *Pleurotoma* (*Surcula*) *eurina* E. A. Smith, Ann. Mag. Nat. Hist. ser. 7, vol. 4, p. 239.

1909 *Pleurotoma* (*Surcula*) *eurina* E. A. Smith, Annandale & Stewart, Illust. Zool. Investigator, Moll., pt. 6, pl. 9, figs. 4, 4a.

*Types*—The holotype is in the Indian Museum, Calcutta.

*Records*—INDIA: off south of India, 430 fathoms (type locality); BORNEO, off Si Amil Island, 890 fathoms, grey mud and fine sand (Albatross Sta. 5582, USNM.).

### *Comitas margaritae* (E. A. Smith, 1904)

(Pl. 217, figs. 1, 2)

*Range*—Off Andaman Islands, 405 fathoms.

*Remarks*—According to the excellent illustrations of Annandale & Stewart (1909, l.c.), this shell resembles the South African *stolida* (Hinds), but has more numerous axials, and a curious wide subsutural bulge, which occupies most of the shoulder slope, leaving only a narrow concavity between it and the tops of the axials.

**Description**—Shell moderately large, 60 mm. ( $2\frac{3}{8}$  inches) in height, fusiform, with tall turreted spire, capacious body-whorl, and only moderately long slightly flexed anterior canal. Spire about  $1\frac{1}{4}$  times height of aperture plus canal. Whorls 12, apex eroded, bluntly angled medially, and from which there extends numerous, rather flexuous, short, protractively oblique narrowly crested axial folds, which do not quite reach the lower suture, estimated at about 14-15 per whorl. Fine rather flexuous spiral striae over the entire surface. Sinus moderate, broadly arcuate, confluent below with a great forward sweep of the thin outer lip. Colour white, covered with a very thin yellowish periostracum.

**Measurements (mm.)—**

height	width
60.0	20.0

**Synonymy—**

1904 *Pleurotoma (Surcula) margaritae* E. A. Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 13, p. 458.

1909 *Pleurotoma (Surcula) margaritae* Smith, Annandale & Stewart, Illustr. Zool. Investigator, Moll., Pt. 6, pl. 14, figs. 2, 2a.

**Types**—The holotype is in the Indian Museum, Calcutta.

**Comitas luzonica new species Powell**

(Pl. 225, fig. 7)

**Range**—Philippines, off Hermana, Mayor Island, Luzon, 940 fathoms, green mud.

**Remarks**—Although this species appears to be allied to *thisbe* and its several subspecies, there are two important differences—the suture is distinctly submargined, and the whole surface, including the shoulder slope is crowded with evenly developed linear-spaced narrow spiral cords.

**Description**—Shell of moderate size, 42 mm. ( $1\frac{5}{8}$  inches) in height, broadly fusiform, with tall turreted spire,  $36^{\circ}$ - $37^{\circ}$ , slightly greater than height of aperture plus canal. Whorls 8+, apical whorls missing, sharply angled at, to a little below middle whorl height. Axials 15-16 per whorl, crisp, narrowly crested, strongly protractively oblique, commencing abruptly at the periphery but not quite reaching the lower suture. Spiral sculpture, firstly with a flat-topped cord, submargining the suture, after which the whorls are crowded both on the shoulder slope and over the whole of the remaining surface with similar

linear-spaced flat-topped cords; the cords override the axials. Base rather rapidly contracted to a deeply excavated neck and ending in a moderately long, flexed, unnotched anterior canal. Sinus moderately deep, broadly arcuate, occupying the whole of the shoulder sulcus and confluent below with the protractive swing of thin outer lip. Operculum relatively large,  $9.5 \times 6$  mm., broadly leaf-shaped, with a terminal nucleus. Colour porcellanous white, with a thin yellowish-brown periostracum, which ceases abruptly on the base, below the level of the aperture.

**Measurements (mm.)—**

height	width
42 +	16.0

**Types**—The holotype is in the United States National Museum, Washington. (Albatross Sta. 5439; USNM. 238476).

**Comitas melvilli (Schepman, 1913)**

(Pl. 217, figs. 6, 7)

**Range**—Kei Islands, Banda Sea, 560 metres and Timor Sea, 918 metres, Indonesia.

**Remarks**—This species is apparently related to *thisbe*, from which it differs mainly in having narrower proportions and a much taller spire, almost twice the height of the aperture plus the canal.

**Description**—(original) "Shell shortly fusiform, with long spire, thin, light yellowish red-brown. Nucleus wanting, remaining whorls 11, angularly convex, concave above, lower part with very oblique, somewhat irregular ribs, forming small tubercles on the upper whorls, thick folds on the lower ones; these ribs are not visible in the excavation, their number is 22 on last whorl; the whole shell is covered with fine growth-striae, intermingled with some coarser ones and very numerous, waved, spiral lirae, as well on the ribs as in the interstices and in the subsutural excavation; last whorl rapidly attenuated below periphery, ending in a rather short, relatively very slender canal, which is nearly white and sculptured with spirals in the same manner as the rest of the shell. Aperture oval, with a blunt angle above, peristome thin, fragile, the sinus according to growth-lines probably wide, but not very deep. Columellar margin regularly curved, but suddenly directed to the left, at the entrance of canal, which is contortedly directed to the left; columellar margin with a white layer of enamel, interior of aperture brown, smooth."



*Measurements (mm.)—*

height	width
62.0	20.0

*Synonymy—*

1913 *Surcula melvilli* Schepman, Siboga Exped., Part 5, Monogr. 49e, p. 422, pl. 27, fig. 7.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—BANDA SEA: near Kei Islands, 560 metres, solid bluish grey mud (type locality); TIMOR SEA: 10° 48.6' S., 123° 23.1' E., 918 metres, fine grey mud (Schepman).

*?Comitas malayana (Thiele, 1925)*

(Pl. 217, fig. 3)

*Range*—Padang, Sumatra.

*Remarks*—This species also is known to me only from the original description and figure, but it appears to have the essential features for inclusion in *Comitas*.

*Description*—Shell small, 13.5 mm. (½ inch) in height, elongate-fusiform, with tall turreted spire, narrow aperture and relatively long and straight but robust weakly notched anterior canal. Whorls 9½, including a smooth globose protoconch of about 2 whorls. Whorls firstly with an adpressed weak subsutural fold followed by a wide concave steeply descending shoulder area to the low-set bluntly rounded peripheral angle, sculptured with rather distant broadly rounded fold-like,

erect axials, which reach the lower suture but do not extend over the base; 8-9 per whorl. Spiral sculpture of linear spaced moderately strong threads, which commence at the peripheral angle, override the axials and continue, gradually diminishing in strength over body-whorl, neck and anterior end. Sinus rather shallow, rounded and occupying most of the shoulder area. Colour reddish-brown.

*Measurements (mm.)—*

height	width
13.5	5.0

*Synonymy—*

1925 *Surcula malayana* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped. vol. 17, Gastr. 2, p. 335, pl. 24, fig. 19.

*Types*—The holotype is in the Zoological Museum, East Berlin.

*Comitas oahuensis new species Powell*

(Pl. 218)

*Remarks*—The generic placing of this species is in some doubt since the apical whorls are missing in the three known specimens. In Dall's manuscript the species was described as a *Gemmula* but both the style of sculpture and the form of the sinus are foreign to that genus.

I have selected *Comitas* since the sinus, form of sculpture, and the general facies of the shell are all closely similar to those features in a new species of *Comitas* from deep water off Japan, i.e., the species erroneously attributed to *Turricula lurida* (Adams & Reeve), in Kira, 1960, Coloured Illustrations of the Shells of Japan, pl. 35, fig. 7.

*Description*—Shell small, 16-18 mm., of light build, fusiform with a tall spire and a moderately long anterior canal. Protoconch and early whorls eroded away in the three known specimens, but the post-nuclear whorls are indicated as between 6 and 7. Spire whorls medially weakly angulate. Firstly there is a weak subsutural fold, followed by a wide steeply descending and slightly concave shoulder slope, to the simple not very prominent peripheral angle. Sculpture of crisp, narrow, closely spaced spiral cords and threads. Two spirals of cord strength lie on the subsutural fold, four threads occupy the shoulder sulcus, and there are four cords from the peripheral angle to the lower suture, each with an intermediate thread, which increases almost to cord strength by the close of the penultimate. Body-whorl and



Plate 218. *Comitas oahuensis* Powell new species. Off Oahu, Hawaiian Islands, 330-294 fathoms, Holotype, USNM no. 190419. 17.3 mm.

base with a closely spaced alternation of cords and subcords, continued as finer closely spaced threads over the anterior end. Axial sculpture in the form of protractively oblique folds, which commence strongly at the periphery but do not quite reach the lower suture. Aperture narrowly pyriform, produced into a rather widely open slightly flexed and recurved anterior canal of only moderate length, with an oblique very slightly emarginate termination. Outer lip thin, with a distinct U-shaped sinus, its apex on the lower half of the shoulder slope; from there the lower margin of the sinus is confluent with the forwardly arcuately produced lower margin of the outer lip. Inner lip a slightly excavated white callus, without a parietal pad. The whole shell is covered with a yellowish-buff periostracum.

height	width	
17.25+ mm.	7.75 mm.	holotype
16.8+ mm.	6.9 mm.	Pailolo Channel, Sta. 3865.

*Type*—The holotype is in the United States National Museum, Washington (USNM190419).

*Records*—HAWAIIAN ISLANDS: Off s. coast of Oahu Island, 330-294 fathoms, bottom temperature 44°F. (Albatross Sta. 3917; USNM190419) (type); off s. coast of Oahu, 299-330 fathoms, bottom temperature 44°F. (Albatross Sta. 3916; USNM335251); Pailolo Channel, 256-283 fathoms, bottom temperature 44.8°F. (Albatross Sta. 3865; USNM173207).

### *Comitas pagodaeformis* (Schepman, 1913)

(Pl. 219, figs. 1, 2)

*Range*—Indonesia, 397-411 metres.

*Remarks*—This species, described as a *Drillia*, certainly has nothing to do with the subfamily Clavinae. It is however turriculid and near to typical *Comitas*. The protoconch is described as of 1½ smooth and inflated whorls, with a laterally inclined nucleus. There is no mention of carination towards the close of the protoconch but all the post-nuclear whorls are strongly medially angulate. The general facies, including the style of axial sculpture is in accord with *Comitas*. “*Drillia*” features are noticeably wanting, i.e. truncated and notched anterior canal, parietal tubercle and narrowly U-shaped sinus. The species somewhat resembles *Pleurotoma* (*Surcula*) *breviplicata* E. A. Smith, 1899, from 185 fathoms off the Andaman Islands.

*Description*—(original) “Shell elongately fusiform, moderately solid, light yellowish-brown, lighter on the canal. Whorls about 11, of which about 1½ form a smooth, inflated, laterally inclined nucleus. Postnuclear whorls angular, very convex, separated by a linear, undulated suture, accompanied by a faint intrasutural rib, more con-

spicuous on upper whorls; upper part of whorls conspicuously excavated, lower part with strong, short, nodulous, oblique ribs, abruptly ending at the excavation, scarcely reaching the basal suture in lower whorls. There are 3 faint, raised, spiral lirae in the excavation, crossed by elegantly curved, partly riblike striae, 4 to 5 stronger lirae crossing the ribs, with a few faint striae above them on the limit between ribs and excavation in lower whorls; on the penultimate whorl, another liration appears at some distance above the suture, amounting to 3 rather remote, strong lirae on last whorl, and a large number (about 20) on basal part of last whorl and canal; body-whorl strongly attenuated below, ending in a long, slightly curved canal. Aperture ovate, probably with a rather wide, deep sinus (the peristome is broken), columellar margin concave above, strongly contorted below, with a thin layer of enamel”.

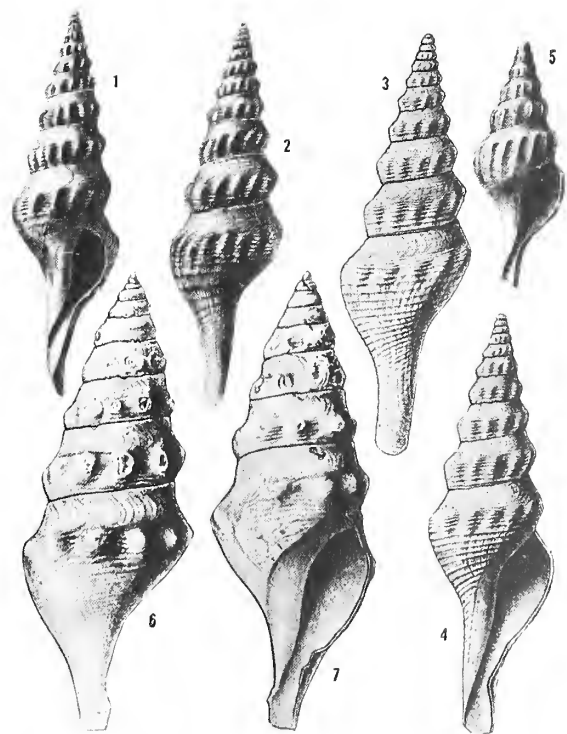


Plate 219. Figs. 1, 2, *Comitas pagodaeformis* (Schepman). Halmahera Sea, 411 metres. 28.7 mm. (from Schepman, 1913, pl. 26, figs. 5a, b). Figs. 3, 4, *Comitas breviplicata* (E. A. Smith). Off Andaman Islands, 185 fathoms. 26.0 mm. (from Annandale & Stewart, 1909, pl. 9, figs. 3, 3a). Fig. 5, *Comitas anteridion* (Watson). 150 fathoms off Cape of Good Hope, South Africa. 22.0 mm. (from Watson, 1886, pl. 19, fig. 6). Figs. 6, 7, *Comitas arcana* (E. A. Smith). Off Andaman Islands, 185 fathoms. 25.0 mm. (from Annandale & Stewart, 1909, pl. 9, figs. 6, 6a).

*Measurements (mm.)—*

height	width
28.7	8.0

*Synonymy—*

1913 *Drillia pagodaeformis* Schepman, Siboga Expedition, Pt. 5, monogr. 49e, p. 409, pl. 26, fig. 5.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—INDONESIA: Halmahera Sea, 0° 59.1'S., 129° 28.8'E., 411 metres; near Kei Islands, 5° 26.6'S., 132° 32.5'E., 397 metres, greyish-green mud.

*Comitas breviplicata* (E. A. Smith, 1899)

(Pl. 219, figs. 3, 4)

*Range*—Off the Andaman Islands, 185 fathoms.

*Remarks*—This species appears to closely resemble the Halmahera *pagodaeformis* (Schepman, 1913). From illustrations, Schepman's species appears to differ from *breviplicata* mainly in being more slender and in having more numerous axials and stronger more distant spirals on the base.

*Description*—Shell of moderate size, 26 mm. (1 inch) in height, elongate-fusiform, with tall spire and long, straight but rather stout, unnotched, anterior canal. Spire a little taller than height of aperture plus canal. Whorls 10, including a paucispiral smooth, subglobose protoconch. Post-nuclear whorls with a sharp median angulation which bears protractively oblique, short, fold-like axials, 13 per whorl, which commence abruptly at the angle and almost reach the lower suture. Spiral sculpture consisting of 5-6 weak threads over the wide lightly concave shoulder sulcus, and stronger, crisp, narrow spirals from below the shoulder, overriding the axials, and then continuing to the anterior end, where they gradually reduce in strength. Sinus indicated as broadly arcuate but deep, occupying the whole of the shoulder area, and confluent below with a great forward sweep of the thin outer lip. Colour white.

*Measurements (mm.)—*

height	width
26.0	8.0

*Synonymy—*

1899 *Pleurotoma* (*Surcula*) *breviplicata* Smith, Ann. Mag. Nat. Hist., Ser. 7, vol. 4, p. 238.

1909 *Pleurotoma* (*Surcula*) *breviplicata* Smith, Annandale & Stewart, Illustr. Zool. Investigator, Moll., pt. 6, pl. 9, figs. 3, 3a.

*Types*—The holotype is in the Indian Museum, Calcutta.

*?Comitas arcana* (E. A. Smith, 1899)

(Pl. 219, figs. 6, 7)

*Range*—Off Andaman Islands, 185 fathoms (type locality) and India, off Travancore coast, 360 fathoms.

*Remarks*—The low-set peripheral nodulose keel in this species suggests *Makiyamaia*, but in that genus the sinus is much narrower at its apex, not broadly arcuate, occupying the whole of the shoulder slope, as in *arcana*. The operculum of *arcana* is unfortunately unknown. Examples of an allied species from the John Murray Expedition, Gulf of Aden in 2000 metres are similar but have a shorter spire and more numerous peripheral nodules.

*Description*—Shell small, 25 mm. (1 inch) in height, fusiform, with tall spire and moderately long, straight anterior canal. Spire slightly greater than height of aperture plus canal. Whorls probably about 10; the apex is badly eroded in the figured holotype. Outline of whorls steeply descending over a broad shallowly concave shoulder area, to a low-set heavy, rounded peripheral keel, which is studded with large blunt tubercles, about 8-9 per whorl. Spiral sculpture consisting of very faint threads on the shoulder slope, a closely spaced series of slightly stronger threads in the interstices of the peripheral nodes and then extending over the base, but becoming obsolete towards the end of the anterior canal. Sinus deep, broadly rounded at its apex and occupying the whole of the shoulder area, produced horizontally forward at its lower extremity and then confluent with the arcuately projected swing of the thin outer lip. Colour white, covered by a light olivaceous periostracum.

*Measurements (mm.)—*

height	width
25.0	9.0

*Synonymy—*

1899 *Pleurotoma* (*Surcula*) *arcana* E. A. Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 4, p. 239.

1909 *Pleurotoma* (*Surcula*) *arcana* Smith, Annandale & Stewart, Illustr. Zool. Investigator, Moll., Pt. 6, pl. 9, figs. 6, 6a.

*Types*—The holotype is in the Indian Museum, Calcutta.



**Comitas anteridion (Watson, 1881)**

(Pl. 219, fig. 5)

*Range*—Off South Africa, 150-230 fathoms. Also recorded from New Amsterdam, South Indian Ocean (requires confirmation).

*Remarks*—If Barnard's identification is correct then his additional characters, combined with Watson's description, make *anteridion* an undoubted inclusion in *Comitas*. These additional characters are the protoconch of 2-2¼ smooth whorls and the operculum with an apical (= terminal) nucleus.

According to Barnard (1958, p. 144), Thiele's record of *anteridion* from New Amsterdam (pl. 24, fig. 13) is not Watson's species but the juvenile figured by Thiele (pl. 25, fig. 3) is correctly identified. Judging from figures alone (drawings in both cases) the New Amsterdam shell appears to have more robust axials but otherwise there seems to be little difference.

*Description*—(original) "Shell high, narrow, biconically fusiform, subscalar, with angularly convex and longitudinally-ribbed whorls, thin, tawny. Sculpture: Longitudinals - a little way below the suture is an angulation where narrow, raised, oblique ribs begin; these slope from right to left; they extend to the suture, but not to the base, where they die out more gradually than they arose; they are parted by rounded hollows, which are wider than the ribs. There are about nineteen of these ribs and hollows on the last whorl, but fewer on each preceding one; besides these, there are very many fine hair-like flexuous lines of growth. Spirals - the shoulder below the suture (the sinus area) has a few faint regular scratch-like lines; on the ribbed area these are stronger. On the base the interstices become somewhat narrower and more convex, till on the snout they rise into strongish threads, which at the very point again become weaker. Colour a light tawny, paler on the snout, and white on the pillar. Spire high, conical, and slopingly subscalar. Apex broken. Whorls probably 10, rather short, with a straight somewhat drooping shoulder, convex, and appearing contracted below in consequence of the dying out of the longitudinal ribs as they approach the suture. The conical base contracts rather rapidly, and is prolonged into the straight, very slightly reverted, direct, narrow cylindrical snout. Suture a fine regular, squarely impressed line, whose course diverges a good deal from that of the spirals of sculpture. Mouth club-shaped, being roundly oval and not

angulated above, and with a long, narrow, slightly twisted canal below. Outer lip sharp and thin, with a very regular curve from the suture to the base of the snout, along the edge of which it runs sharp and straight to the open, rounded, and thin point; when it leaves the body, it retires at once to the left, forming a deep, rounded open sinus; from this point its edge sweeps out in a full convex curve, retreating slightly at the base of the snout, and then advancing straight to the point. Inner lip porcellanous, longitudinally marked, narrow, straight, cut away obliquely to a long fine point; and then continued along the canal in a thin sharp edge, which towards the point is slightly cut off backwards."

*Measurements (inches)*—

height	width
0.9	0.32

*Synonymy*—

- 1881 *Pleurotoma (Surcula) anteridion* Watson, Journ. Linn. Soc., London, vol. 15, p. 399.  
 1886 *Pleurotoma (Surcula) anteridion* Watson, Challenger Zool. vol. 15, p. 295, pl. 19, fig. 6.  
 1925 *Surcula anteridion* Watson, Thiele, Deutschen Tiefsee-Exped., "Valdivia", vol. 17, Gast. 2, p. 223, pl. 25, fig. 3 (& ?, pl. 24, fig. 13, New Amsterdam).  
 1958 *Clavatulula (Surcula) anteridion* (Watson), Barnard, Ann. S. African Mus., vol. 44, p. 144.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—SOUTH AFRICA: off Cape of Good Hope, 150 fathoms (type locality); off Cape Point, west coast of Cape Peninsula and Table Bay, 180-230 fathoms (Barnard); New Amsterdam, on Central Indian Rise (Thiele) requires confirmation).

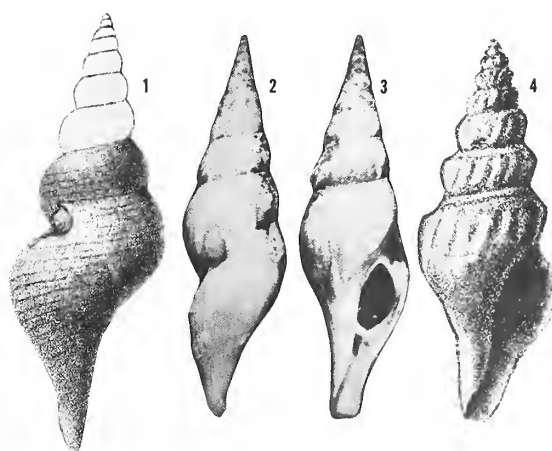


Plate 220. Fig. 1, *Comitas? rotundata* (Watson). Mid-Pacific, east of Japan, 2050 fathoms. About 42.0 mm. (from Watson, 1886, pl. 21, fig. 6). Figs. 2, 3, *Comitas kuroharai* (Oyama). Off Tosa, 100 metres, Japan. 70.0 mm. (from Oyama, 1962, p. 56, figs. 1, 2). Fig. 4, *Comitas? halicyria* (Melvill). Gulf of Oman, 225 fathoms. 32.0 mm. (from Melvill, 1904, pl. 10, fig. 16).

**? *Comitas rotundata* (Watson, 1881)**

(Pl. 220, fig. 1)

*Range*—Mid-Pacific, east of Japan, 36° 10'N., 178° 0'E., 2050 fathoms.

*Remarks*—This species is known only from the fragmentary holotype which consists of just the body and penultimate whorls. The sinus is more in accord with that of *Comitas* rather than with that of *Leucosyrinx*. The main features of the shell are the evenly rounded, strongly convex whorls, and the rather distant sculpture of relatively strong but unequal sharpish spiral threads. The only axial sculpture is in the form of close-set, hair-like growth lines, which, however, tend to thicken subsuturally. Colour white under a thin yellowish epidermis.

*Measurements (mm.)—*

height	width	
ca. 29	15	fragment; from figure
ca. 42	15	restored; from figure

*Synonymy—*

- 1881 *Pleurotoma (Surcula) rotundata* Watson, Journ. Linn. Soc., London, vol. 15, p. 393.  
 1886 *Pleurotoma (Surcula) rotundata* Watson, Challenger Zoology, vol. 15, p. 290, pl. 21, fig. 6.

*Types*—The holotype is in the British Museum (Natural History).

***Comitas kuroharai* (Oyama, 1962)**

(Pl. 220, figs. 2, 3)

*Range*—Japan, off southwest Tosa in about 100 metres.

*Remarks*—This species, which I have not seen, seems undoubtedly a *Comitas*, but close alliance with *kaderlyi*, as suggested by its author, is unlikely; it is probably nearer allied to *Spergo?* *sibogae* Schepman, 1913, from near the Kai Islands, 560 metres, Banda Sea.

*Description*—(original)—“Shell large, elongate-fusiform, with a high spire. Whorls tall, with more or less obsolete axial ribs and fine spiral sculpture; body-whorl elongated; aperture long and narrow; outer lip sinuated on the shoulder; canal long, straight; columella without plication; operculum leaf-shaped, with an apical nucleus.”

*Measurements (mm.)—*

height	width
70.0	20.0

*Synonymy—*

- 1962 *Turricula kuroharai* Oyama, Venus, vol. 22, part 1, p. 56, text figs. 1, 2.

***Comitas chuni* (von Martens, 1902)**

(Pl. 221, fig. 1)

*Range*—Off west coast of Sumatra in 1143 metres, Indonesia.

*Remarks*—The figure of this species, which was referred to *Pontiothauma* by von Martens (1903), suggests by the growth lines, a rather deep turriculid style sinus, quite foreign to that of *Pontiothauma*, which has at most, a very weak sutural sinus. Martens' species seems to be somewhat allied to Schepman's *Spergo sibogae* from near the Kei Islands, Indonesia in 560 metres. Both species fit reasonably well into the genus *Comitas*.

*Description*—Shell large, estimated at about 106 mm. (4<sup>1</sup>/<sub>4</sub> inches) in height. Spire tall, greater than height of aperture plus canal (anterior end missing in the unique holotype). Post-nuclear whorls 8 (protoconch missing). Whorls inflated, without a peripheral angulation, but there is a moderately wide subsutural concavity. Sculpture of numerous narrowly rounded but rather strong protractively obliquely arcuate axials, which do not reach the lower suture. The whole surface is crowded with fine crisp spiral lirae.

*Measurements (mm.)—*

height	width
93 (actual)	35

*Synonymy—*

- 1902 *Pleurotoma (Pseudomata) chuni* von Martens, Sitzungsberichte d. Gesell. naturf. Freunde, Berlin, p. 19.  
 1903 *Pontiothauma* (sic) *chuni*, von Martens, Gast. deutsch. Tiefsee-Exped., Bd. 7, p. 86, pl. 1, fig. 10.

**? *Comitas sibogae* (Schepman, 1913)**

(Pl. 221, figs. 2, 3)

*Range*—Near the Kai [Kei] Islands, Banda Sea, 560 metres, Indonesia.

*Remarks*—This species, referred with considerable doubt to *Spergo*, by its author, is considered to have nearer relationship with the *Comitas* group. However, since the protoconch and the operculum are both unknown the final resting place for the species is still conjectural. One reason for aligning this species with *Comitas* is that I have seen a somewhat similar shell from Burma, in the collection of the Indian Zoological Survey, which has an operculum with a terminal nucleus.

*Description*—(original)—“Shell fusiform, rather strong, yellowish-brown. Nucleus wanting, remaining whorls 9, moderately convex, slightly

excavated below the conspicuous but shallow suture. Sculpture consisting of remote, oblique, axial ribs, conspicuous in upper whorls, fainter lower on, disappearing on back of last whorl, forming tubercles below the excavation, which in upper whorls bears short plicae, just below the suture; the lower part of whorls is crossed by very numerous spiral striae, conspicuous on upper whorls, faint on last one, but stronger towards and on the canal. Aperture elongately-oval, angular above, with wide canal below; Peristome damaged, according to the fine growth-lines, with a very shallow sinus above, then regularly arched; columellar margin concave above, then nearly straight, at last slightly directed to the left. Covered with a layer of enamel, which is thin above, stronger below. Interior of aperture smooth."

*Measurements (mm.)—*

height	width
54.0	18.0

*Synonymy—*

1913 *Spergo* ? *sibogae* Schepman, Siboga Exped., vol. 49 pt. 1e, p. 448, pl. 30, fig. 9.

*Types—*The holotype is in the Zoological Museum, Amsterdam.

*? Comitas symbiotes*

(Wood-Mason & Alcock, 1891)

(Pl. 221, fig. 4)

*Range—*Off southern India, 1043 fathoms, and Malaya, 700 fathoms.

*Remarks—*This species and the closely allied *Pleurotoma* (*Surcula*) *subcorpulenta* (Smith, 1894) are large shells of light build, with angulate axially plicate spire-whorls, but upon approaching maturity, the whorls tend to become more roundly inflated, and the axials and carina to become subobsolete. The operculum is small, almost to the point of being vestigial, and is oval to leaf-shaped with a terminal nucleus. The sinus is broad and shallow, occupying the whole of the shoulder slope. The presence of a faint entering plication within the inner-lip callus, suggests that these shells may be better placed in the *Borsoniinae*, but the significance of such weak plications is as yet not clearly understood. For the present only those species with well developed columellar plications are grouped in the *Borsoniinae*.

The Malayan specimen, here ascribed to this species, has a taller, more slender spire than in

the Indian type specimen, but too few examples are available to even decide if *subcorpulenta* is really distinct, a point about which Smith (l.c.) had some doubts.

*Description—*Shell large, 54-59 mm. (2-2¼ inches) in height, light build, elongate-fusiform, with tall attenuated turreted spire and capacious body-whorl contracted to a rather short slightly flexed spout-like unnotched anterior canal. Whorls 10-11 but nucleus eroded away. Spire taller than height of aperture plus canal, weakly angulated below the middle of whorl height. Sculpture of protractively flexuous fold-like axials, extending from just above the shoulder angle to the lower suture, about 12 per whorl. Both the peripheral angle and the axials become subobsolete over the body-whorl. The whole surface crowded with wavy spirals, 7-8 threads on the shoulder slope and about 6 cords between

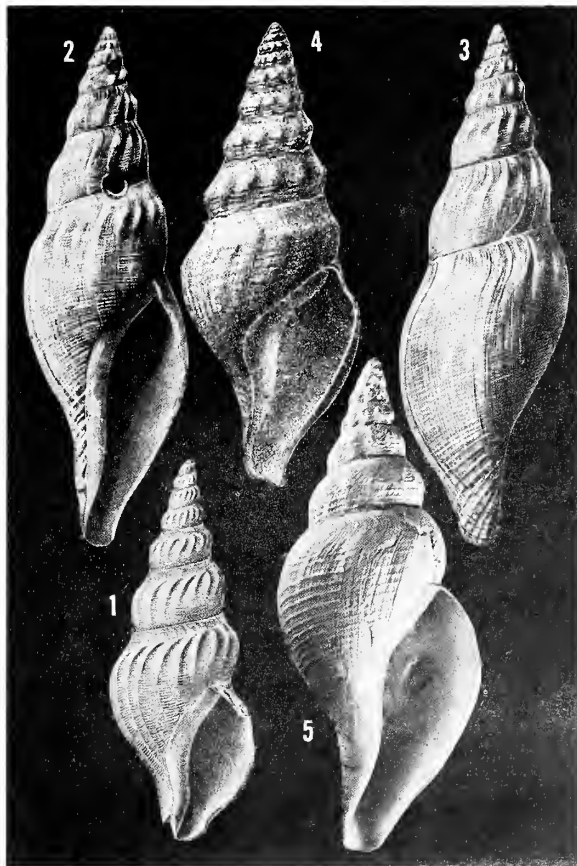


Plate 221. Fig. 1, *Comitas chuni* (von Martens, 1902). Off west coast of Sumatra, 1143 metres. About 106 mm. (from von Martens, 1903, pl. 1, fig. 10). Figs. 2, 3, *Comitas sibogae* (Schepman). Near Kai Islands, Banda Sea, 560 metres. 54.0 mm. (from Schepman, 1913, pl. 30, fig. 9). Fig. 4, *Comitas symbiotes* (Wood-Mason & Alcock). Off Southern India, 1043 fathoms. 57.0 mm. (from E. A. Smith, 1894, pl. 3, fig. 7). Fig. 5, *Comitas symbiotes subcorpulenta* (E. A. Smith). Holotype, off Colombo, Ceylon, 675 fathoms. 80.0 mm.



the periphery and the lower suture; cords continue, closely spaced, over the body-whorl and neck, but the weak anterior fasciole is plain. Sinus shallow, broadly arcuate, confluent in a sigmoid curve with a moderate forward projection of the thin outer lip. The highly glazed inner-lip callus bears a very weak, scarcely apparent, entering plication, situated above the middle and well within the aperture. Suture irregularly undulated. Colour dull white, covered by a very thin pale olivaceous periostracum. Operculum small, oval, with a terminal nucleus.

*Measurements (mm.)—*

height	width	
57.0	19.0	(holotype)
54.0	19.5	Bouro Island, Malaya, 700 fathoms.

*Synonymy—*

- 1891 *Pleurotoma symbiotes* Wood-Mason & Alcock. Ann. Mag. Nat. Hist., ser. 6, vol. 8, p. 444, figs. 13a, b.  
 1894 *Pleurotoma (Surcula) symbiotes* Wood-Mason & Alcock, Smith, Ann. Mag. Nat. Hist. ser. 6, vol. 14, p. 161, pl. 3, figs. 7, 8.

*Types*—The holotype is in the Indian Museum, Calcutta.

*Records*—INDIA: off the southern extremity, 7° 04'N., 76° 34' 15"E., 1043 fathoms (type locality). MALAYA: off Bouro Island, 700 fathoms, grey mud and sand (Albatross Sta. 5637, USNM.).

? *Comitas symbiotes subspecies*

*subcorpulenta* (E. A. Smith, 1894)

(Pl. 221, fig. 5)

*Range*—Off Colombo, Ceylon, 6° 32'N., 79° 37'E., 675 fathoms.

*Remarks*—Smith's shell differs from *symbiotes*, mainly in being larger, with a shorter spire and a more capacious body-whorl; the paratype in the British Museum has the body-whorl with the shoulder angulation quite obsolete. Smith (l.c.) remarked that "one of the two specimens under examination has a distinct oblique fold on the columella". Note the smallness of the operculum in relation to the size of the aperture, as shown in the photographic figure of the paratype, in the British Museum (Pl. 44, fig. 5).

*Measurements (mm.)—*

height	width
80.0	29.0

*Synonymy—*

- 1894 *Pleurotoma (Surcula) subcorpulenta* Smith, Ann. Mag. Nat. Hist. ser. 6, vol. 14, p. 161, pl. 3, fig. 6.

*Types*—The holotype is in the Indian Museum, Calcutta; paratype in the British Museum (Natural History).

*Comitas thisbe* (E. A. Smith, 1906)

(Pl. 225, figs. 1, 2)

*Range*—East of Ceylon in 1086 fathoms.

*Remarks*—The chief characteristics of this species are the smooth shoulder sulcus, unmarginated above, and the numerous short protractively oblique peripheral axials, which become obsolete before reaching the lower suture. Except for the shoulder sulcus the surface is delicately spirally wavy-striated throughout.

I have not seen the unique holotype but the excellent figures of Annandale & Stewart, 1909, pl. 20, show that there is relationship with *melvilli* Schepman, 1913, from Indonesian waters, a species with a much taller spire, and also with another Indonesian and two Philippine shells, described following.

*Description*—Shell of moderate size, 44 mm. (1¾ inches) in height, of light build, fusiform, with turreted spire, a little taller than height of aperture plus canal. Body-whorl rather broadly capacious but excavated over the neck to a slightly flexed, rather short, unnotched anterior canal. Whorls about 10, apex badly eroded, angulated at about two thirds whorl height, marking off a smooth shoulder sulcus, without a subsutural margining. Axials strongly obliquely protractive rather narrow folds, which commence abruptly at the angulation but do not quite reach the lower suture; about 19 per whorl. Surface other than the shoulder sulcus, densely but delicately wavy striated. Sinus moderate, broadly arcuate, occupying the whole of the shoulder sulcus. Colour dull white.

*Measurements (mm.)—*

height	width
44.0	14.0

*Synonymy—*

- 1906 *Pleurotoma (Surcula) thisbe* E. A. Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 162.  
 1909 *Pleurotoma (Surcula) thisbe* Smith, Annandale & Stewart, Illustr. Zool. Investigator, Moll. pt. 6, pl. 20, figs. 1, 2.

*Types*—The unique holotype is in the Indian Museum, Calcutta.

***Comitas thisbe* new subspecies  
diomedea Powell**

(Pl. 225, figs. 3, 4)

*Range*—Indonesia, Celebes, 540-559 fathoms.

*Remarks*—This subspecies differs from the typical species in having the peripheral angle below the middle of whorl height, and the oblique axial ribs even shorter, fading out before the lower suture is reached, despite the fact that the peripheral angle is lower than in the typical species.

*Description*—Shell of moderate size, 49 mm. (2 inches) in height. Whorls about 10, apex badly eroded, angulated at just below middle whorl height, which results in a wider, less concave shoulder sulcus. Axials short very oblique folds, 16-17 per whorl, commencing abruptly at the periphery and fading out about half way to the lower suture. Spiral sculpture almost obsolete on the shoulder area, a few faint traces here and there, but dense wavy threads over the remaining surface. Sinus deep, rather narrowly rounded at the apex but occupying the whole of the shoulder sulcus, and confluent below with a great arcuate protractive swing of the thin outer lip. Colour dull white, covered with a very thin pale yellowish periostracum. Operculum leaf-shaped, with a terminal nucleus (Pl. 213, fig. 1)

*Measurements (mm.)—*

height	width
49.0	17.5

*Types*—The holotype is in the United States National Museum, Washington, D.C. (USNM, 239425).

*Records*—CELEBES: off Tg. Lamulu, Gulf of Boni, 540 fathoms, green mud (Albatross Sta. 5650; USNM) (type locality); off North Island, Buton Strait, 559 fathoms, green mud (Albatross Sta. 5648; USNM).

***Comitas yokoyamai* (Oyama, 1954)**

(Pl. 222, figs. 1, 2)

*Range*—Japan, Koshiha Zone, Pliocene.

*Remarks*—This species is based upon an imperfect shell originally erroneously recorded by Yokoyama as *Pleurotoma kamakurana* Pilsbry, which is a Recent Japanese shell with much longer and stronger axial ribs. Yokoyama's shell was renamed *Cryptogemma yokoyamai* by Oyama in selected reprints of Yokoyama's plates, contained in Taki and Oyama, 1954 (Palaeont. Soc. Japan spec. papers, No. 2, p. 24 and description of pl. 2). However, the sinus, which is clearly shown in Yokoyama's pl. 1, fig. 17b, to be on the

shoulder slope, precludes the use of the turrid genus *Cryptogemma*. The shell in fact, appears to be nearest allied to *Comitas kirai*, a new species provided in this number to replace *Turricula lurida* of Japanese authors (non Adams & Reeve, 1850). From *kirai*, the Pliocene *yokoyamai* differs in having more numerous and longer axials.

*Description*—(original: i.e. Yokoyama, 1920). "This shell is elongate-fusiform in shape, with the canal nearly as long as the spire; the whorls are very convex, almost angular, concave above and appressed at the suture. The sculpture consists of numerous short vertical folds and numerous subequal crowded spiral threads. The vertical folds on the body-whorl do not reach the level of the upper angle of the shell-aperture, becoming obsolete as they approach that level. The aperture is longly oval, passing below into a long, open, straight canal. Sinus wide and shallow; outer lip gently arched forward."

*Measurements (mm.)—*

No sizes are given but from the figure, presumed to be natural size, the restored dimensions of the damaged original specimen are estimated as:—

height	width
41.0	13.5

*Synonymy—*

1920 *Pleurotoma kamakurana* Pilsbry (non Pilsbry, 1895), Yokoyama, Journ. Coll. Sci. Imper. Univ. Tokyo, vol. 39 no. 6, p. 35, pl. 1, fig. 17.

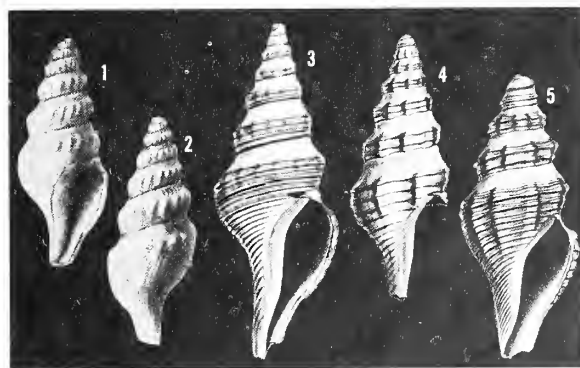


Plate 222. Figs. 1, 2, *Comitas yokoyamai* (Oyama). Japan (Koshiha zone, Pliocene). About 41 mm. (from Yokoyama, 1920, pl. 1, fig. 17). Fig. 3, *Comitas allani* Powell. New Zealand, Devil's Elbow, Hawke's Bay. 26.7 mm. (Nukumaruan, Lower Pleistocene). Fig. 4, *Comitas (Carinacomitas) subcarinapex* Powell. New Zealand, Clifden, Southland (Miocene). 10.5 mm. (from Powell, 1942, pl. 10, figs. 6, 5). Fig. 5, *Comitas (Carinacomitas) aldingensis* Powell. South Australia, Aldinga (Eocene). 6.8 mm. (from Powell, 1944, pl. 1, fig. 7).

1954 *Cryptogemma yokoyamai* Oyama, Palaeont. Soc. Japan, spec. papers No. 2, p. 24 and description of pl. 2, fig. 17; nom. nov. for *Pl. kamakurana*, Yokoyama, 1920 (non Pilsbry, 1895).

*Records*—JAPAN: Koshiha Zone, Koshiha (type locality) and Kanazawa Zone at Nojima, Kanazawa and Teramac, Pliocene.

### *Comitas albicincta* (Adams & Reeve, 1850)

(Pl. 223, fig. 1)

*Remarks*—A photograph of the holotype of this species shows a very different looking shell from the original coloured figure of Adams & Reeve. The actual shell is of more slender outlines and the basal subsutural cord, prominent in the illustration is in fact no stronger than a series of similar rather distant cords, below it on the lower base and neck.

The now faded appearance of the holotype in comparison with the coloured illustration is expected in a shell over 120 years old, and one that in the past must have been on public exhibition for much of that period.

*Description*—Following is the original description, which, although brief, at least records the former condition of the type so far as colour is concerned:—“Pleur. testâ subabbreviato-fusiformi, anfractibus decem, transversim subtiliter striatis, supernè concavo-declivibus, deinde obliquè plicato-nodatis, sinu latiusculo; fulvescente, saturatè variegatâ, medio albizonatâ. Hab. China Sea. The white zone passes over the nodules upon the angle in the centre of each whorl.”

Shell of medium size, 24.5 mm. (1 inch) in height, narrowly fusiform, with tall spire, long body-whorl and relatively short anterior canal. Height of spire about equal to that of aperture plus canal. Whorls ten, including a blunt paucispiral protoconch. Spire-whorls medially bluntly angulated by a heavy peripheral keel which is sculptured with strong short oblique axial nodes, four to five showing in front view of the shell, which equals 7-8 per whorl. The nodes do not extend up over the wide steeply descending shallowly concave shoulder area, and become subobsolete to obsolete before the lower suture is reached. A second very weak subangle occurs at about the middle of the base. There is no subsutural margining. The whole surface of the post-nuclear whorls is sculptured with closely spaced fine spiral threads plus about nine evenly spaced rather distant stronger threads, almost cords, which are disposed on the base from just below the top of the aperture to the anterior end. The aperture is very long and narrow and terminates in a short recurved canal with a weakly notched extremity. The sinus is broadly arcuate, of moderate depth and occupies much of the shoulder area. The present coloration is pale brown with a white band which encircles the periphery.

#### *Measurements (mm.)*—

height	width	
24.5	8.5	(holotype)

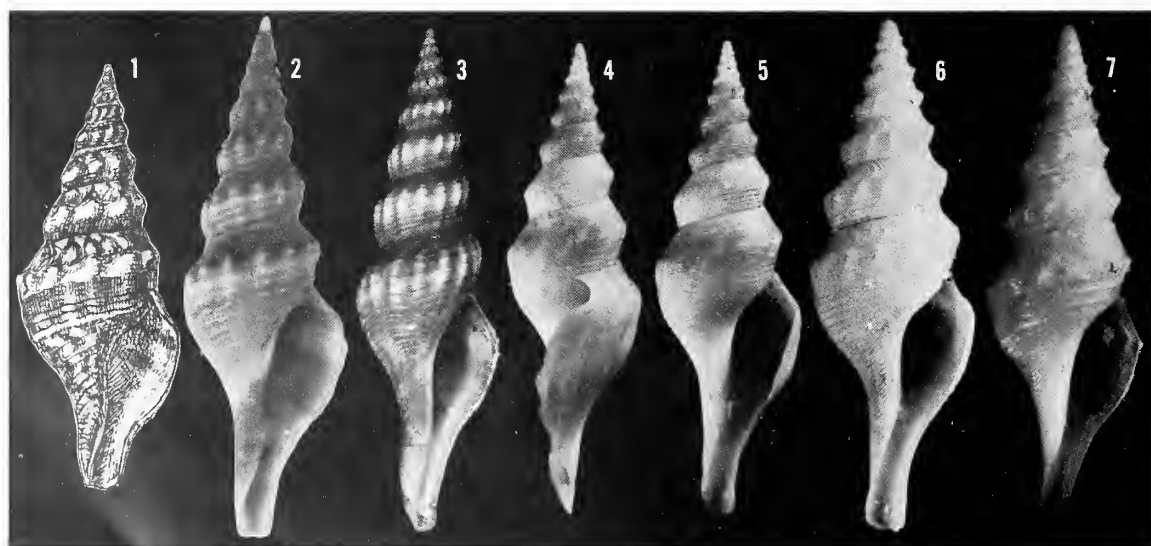


Plate 223. Fig. 1, *Comitas albicincta* (Adams & Reeve). China Sea. 24.5 mm. (from Adams & Reeve, 1850, pl. 10, fig. 6). Fig. 2, *Comitas lurida* (Adams & Reeve). China Sea. 38.5 mm. (from Adams & Reeve, 1850, pl. 10, fig. 5). Fig. 3, *Comitas kamakurana* (Pilsbry). Tosa, Japan. 55.0 mm. Figs. 4-6,

*Comitas kirai* Powell, new species. Figs. 4, 5, holotype, Kii, Japan, dredged, 30.5 mm. Fig. 6, paratype, off Pratas Islands, 208 fathoms, South China Sea. 36.5 mm. Fig. 7, *Comitas suluensis* Powell new species. Holotype, off Cagayan Island, 508 fathoms, Sulu Archipelago. 21.0 mm.



*Synonymy*—

1850 *Pleurotoma albicincta* Adams & Reeve, Zool. Voy. H. M. S. Samarang, Moll., p. 40, pl. 10, f. 6.

*Types*—The holotype is in the British Museum (Natural History). I have not seen other material of this species.

*Records*—CHINA SEA (type locality).

**Group of *Comitas lurida******Comitas lurida* (Adams & Reeve, 1850)**

(Pl. 223, fig. 2)

*Remarks*—This species name has been used by Japanese authors for a deep-water species which differs markedly from the “China Sea” holotype, in that there is no subsutural margining and the axials are protractively oblique and more numerous. So far I have not seen material that matches the unique holotype.

Examination of the holotype of *lurida* reveals a shell much closer to *kamakurana* than it is to the so called “*lurida*” of Kira (1960, Coloured Illust. Shells of Japan, pl. 35, fig. 7). The type of *lurida* differs from *kamakurana* in having a submarginated suture, fewer axials, a more prominent bluntly rounded shoulder angle and a deeper sinus. When more is known about *lurida* the relationship between that species and *kamakurana* may prove to be only subspecific.

*Description*—(original) “Pleur. testa gracilifusiformi, anfractibus decem, transversim subtiliter striatis, superne concavo-angulatis, ad angulum plicato-nodosus et transversim obtuse costatus, sinu subamplo; ferrugineo-fusca, infra angulum albida. Hab. China Sea. A shell of light substance, in which the sculpture is of a tremulous or corrugate character.”

Shell of medium size, 38.5 mm. (1½ inches) in height, elongate-fusiform, with tall turreted spire, narrow body-whorl and moderately long slightly flexed unnotched anterior canal. Spire about equal to height of aperture plus canal. Whorls ten including a paucispiral protoconch, estimated at 1½-2 smooth whorls. Post-nuclear sculpture of numerous short axial folds, absent from the shoulder area and becoming subobsolete to obsolete before the lower suture is reached. Axials estimated at about ten per whorl. Spiral sculpture consisting of a moderately strong subsutural cord, weak threads on the shoulder area, four relatively strong cords over the broadly rounded peripheral angle and weaker narrow cords continued over the base and neck. Three of the peripheral cords develop rounded tubercles

where they cross the axials. Sinus of moderate depth, situated at about the middle of the shoulder area. Colour reddish-brown with two white spiral bands, one peripheral and the other at the neck.

*Measurements (mm.)*—

height	width	
38.5	12.0	(holotype)

*Synonymy*—

1850 *Pleurotoma lurida* Adams & Reeve, Zool. Voy. H. M. S. Samarang, Moll., p. 40, pl. 10, fig. 5.

1942 *Brachytoma lurida* (Adams & Reeve), Yen, Proc. Mal. Soc. London, vol. 24, p. 239, pl. 25, fig. 185 (holotype)

*Types*—The holotype is in the British Museum (Natural History), Reg. no. 74. 12. 11. 291.

*Records*—CHINA SEA (type locality)

***Comitas kirai* new species Powell**

(Pl. 223, figs. 4-6)

*Remarks*—This is the species figured by Kira, 1960, in “Coloured Illustrations of Japanese Shells”, pl. 35, fig. 7. From *lurida* it differs in the lack of a submarginating of the suture, more numerous and protractively oblique, not vertical, axials, the addition of a basal subangle and pale coloration, faintly banded, but differently from *lurida*, the uppermost band being at the peripheral angle whereas that is the site of the white band in both *lurida* and *kamakurana*.

*Description*—Shell of medium size, 30-36 mm. (ca. 1-1½ inches) in height, of light build, narrowly fusiform, with tall turreted spire, sharply angled medially, narrow aperture and moderately long slightly flexed unnotched anterior canal. Whorls 10½, including a blunt paucispiral smooth protoconch of about 2 whorls, the top vertically compressed and medially carinate over the last half whorl, followed by several brephic axials (Pl. 211, fig. 3). Spire-whorls without a subsutural margining; shoulder area almost straight and steeply descending to a median bluntly angulate periphery. Sculpture of moderately strong short protractively oblique axial folds, 14-15 per whorl, which are restricted to the peripheral area. The whole surface crossed by spiral threads and weak cords. About six threads on the shoulder area, 3-4 cords on the peripheral angle and 3-4 below it. Cords continued over the base and neck and with one or two threads in most interspaces. Sinus moderately deep, occupying most of the shoulder area and confluent below with a forward arcuate swing of the thin outer lip, which contracts gradually below to the

anterior canal. Colour cream with two bands of light yellowish-brown, one encircling the peripheral nodes and the other at about the middle of the base.

*Measurements (mm.)—*

height	width
36.5	11.7
30.5	9.5

*Synonymy—*

1960 *Turricula lurida* (Adams & Reeve), Kira, Coloured Illust. Shells of Japan, pl. 35, fig. 7 (non Adams & Reeve, 1850).

*Types—*The holotype is in the Academy of Natural Sciences of Philadelphia.

*Records—*JAPAN: Kii, dredged (S. Yukawa; ANSP). SOUTH CHINA SEA: Pratas Islands, 208 fathoms, grey mud and sand (Albatross Sta. 5301, USNM).

*Comitas suluensis* new species Powell

(Pl. 223, fig. 7)

*Range—*Sulu Archipelago, 508 fathoms, off Cagayan Island.

*Remarks—*This species somewhat resembles *kirai* but the peripheral angulation is well below middle whorl height, resulting in a wider, more steeply descending shoulder slope, the axials are pointed tubercles rather than short oblique folds, and there is a subsutural band of small gemmules at the beginning of the axial growth lines. In *kirai* the growth lines are more prominent over the shoulder slope but they do not form gemmules at the suture.

*Description—*Shell rather small, 21 mm. ( $\frac{3}{4}$ – $\frac{7}{8}$  inch) in height, pure white and of light build, elongate-fusiform, with tall spire and moderately long straight, unnotched anterior canal. Spire height one and one sixth times height of aperture plus canal. Whorls 9, including a blunt depressed-globose protoconch of  $1\frac{1}{2}$  whorls, with an asymmetric slightly inrolled tip, the whole followed by a brephic stage of a quarter whorl of weak flexuous axials. Spire-whorls sharply carinated at about a third whorl height, the carina bearing crisp pointed tubercles, 14–15 per whorl. Shoulder area wide, only slightly concave, steeply descending and almost devoid of spiral sculpture; a few faint threads only, appearing on the later whorls. Between the peripheral carina to the lower suture, one or two weak but distinct spiral cords appear, followed by a third just below the level of the top of the aperture; weaker, but distinct linear-spaced threads cover the remainder of the base, neck and anterior canal. Apart from

the tubercles the only other axial sculpture is in the form of fine regular growth lines, which define the curves of the sinus on the shoulder slope, and thicken at their point of contact with the upper suture to form a beaded collar. The sinus is broad, moderately deeply concave and the outer lip is projected forward in a broadly arcuate sweep, contracted and insinuated a little below, over the region of the neck.

*Measurements (mm.)—*

height	width
21.0	7.0

*Types—*The holotype is in the United States National Museum, Washington (USNM, 238399).

*Records—*SULU ARCHIPELAGO, 508 fathoms off Cagayan Island (Albatross Sta. 5423, USNM).

*Comitas kamakurana* (Pilsbry, 1895)

(Pl. 223, fig. 3)

*Remarks—*This and related species are referred to *Comitas*, in the broad sense, mainly on account of the style of sculpture and the relatively shallow sinus.

The species described by Dall, 1919 (l.c.) as *Turricula (Surcula) laysanica*, allegedly from Laysan Island, towards the western end of the Hawaii-Midway Chain, is an absolute synonym of the Japanese *Pleurotoma kamakurana* Pilsbry, 1895.

Dall's species is based upon a single somewhat worn and faded specimen, which he obtained from the late Mr. W. H. Golisch of Los Angeles. From personal experience I found Mr. Golisch to be somewhat unreliable with locality data, so the Laysan record is suspended for want of confirmation.

*Description—*Shell of medium size, 45–55 mm. ( $1\frac{3}{4}$ – $2\frac{3}{4}$  inches) in height, elongate-fusiform with rounded whorls, tall spire and moderately long slightly flexed unnotched anterior canal. Spire slightly taller than aperture plus canal. Whorls 8– $8\frac{1}{2}$ , plus a small smooth papillate protoconch of  $1\frac{1}{2}$ –2 whorls, the last whorl subangulate. Post-nuclear sculpture of numerous short axial folds, 12–16 per whorl, which are absent from the shoulder area and fade out rapidly on the base, crossed by linear spaced smooth spiral cords, which commence just above the shoulder subangle and continue to the extremity of the anterior canal. Spire whorls with an unmargined adpressed suture, a smooth shoulder area and 7–8 primary spiral cords to the lower

suture; of the latter, cords 2 to 4 are somewhat stronger than the rest. Sinus rather shallow, with a narrowly rounded apex situated below the middle of the shoulder area. Outer lip thin. Colour yellowish-brown with two white spiral bands, one coincident with the three stronger peripheral cords and the other at about the middle of the base.

*Measurements (mm.)—*

height	width	
55.0	14.7	Sagami Bay
53.0	15.0	(holotype)
47.0	13.0	Tosa

*Synonymy—*

1895 *Pleurotoma kamakurana* Pilsbry, Cat. Marine Moll. of Japan, Stearns, Detroit, p. 16, pl. 2, figs. 15, 16.

1919 *Turricula (Surcula) laysanica* Dall, Proc. U.S. Nat. Mus. vol. 56, p. 3, pl. 1, fig. 4.

1955 *Turricula kamakurana* (Pilsbry), Kira, Coloured Illust. Shells of Japan, pl. 35, f. 6.

*Types*—The holotype of *kamakurana* is in the Academy of Natural Sciences, Philadelphia, and that of *laysanica* is in the United States National Museum, Washington.

*Records*—JAPAN: Kamakura (type locality); Tosa (A. R. Cahn; ANSP), Sagami Bay (Thaanum coll., Bishop Mus.).

***Comitas variabilis* (Schepman, 1913)**

(Pl. 224, fig. 1)

*Range*—Off Ceram, Indonesia, deep water.

*Remarks*—This species seems to belong to the *lurida* group. It differs from the other members of that group in the low position of the nodulose peripheral carina which is just above the lower suture.

*Description*—(original). "Shell elongately fusiform, with long canal, thin, yellowish-white. Whorls 8, of which about 2 (if normal) form a smooth, slightly inflated, reddish-brown nucleus; post-nuclear whorls subangular, concave in their upper part, separated by a conspicuous waved suture. Sculpture consisting of a row of tubercles at the periphery, sharper in upper whorls, more obtuse lower on, a row of granules, just below the suture, becoming scarcely visible in last whorl and entirely or nearly wanting in some specimens, the lower part of whorls with 1 or 2 rather faint, spiral lirae, the part of last whorl below the keel, with more or less conspicuous spirals, which vary from regular flat lirae to more irregular rib-like ones; in the latter case mainly 2 spirals are stronger; moreover there are extremely fine spiral striae and rather conspicuous

growth-striae. Aperture elongated, angular above, peristome thin, with a wide sinus above, then protracted, columellar margin nearly straight, only slightly concave above, ending in a rather long, narrow canal, covered with a thin layer of enamel. Interior of aperture smooth.

*Measurements (mm.)—*

height	width
18.5	6.0
13.5	5.0

*Synonymy—*

1913 *Surcula variabilis* Schepman, Siboga Exped., vol. 49, pt. 1e, sect. 5, p. 425, pl. 28, fig. 1.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—CERAM SEA, 178° 2' 40"S., 128° 37.5'E., blue mud, 835 metres. I have not seen this species.

**Group of *Comitas undosa***

Three shells, *Surcula undosa* Schepman, 1913, *Leucosyrinx aequatorialis* Thiele, 1925 and *Comitas aequatorialis palawanica*, described following, appear to be very closely allied. All three are characterised by obsolescence of the peripheral nodes on the last whorl. The East African *aequatorialis* and the Philippine *palawanica* are of similar appearance, but both differ from the Indonesian *undosa* in having an inflated body-whorl.

In *aequatorialis* the peripheral tubercles become obsolete after the 4th. post-nuclear whorl but they extend over 7½-8 whorls in *palawanica*.

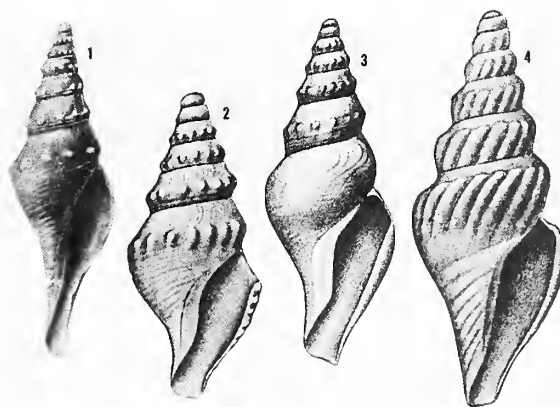


Plate 224. Fig. 1, *Comitas variabilis* (Schepman). Ceram Sea, Indonesia, 835 metres. 18.5 mm. (from Schepman, 1913, pl. 28, fig. 1). Fig. 2, *Comitas laura* (Thiele). East Africa, off Kenya in 693 metres. 8.0 mm. Fig. 3, *Comitas aequatorialis* (Thiele). East Africa, off Somali Coast in 1644 metres. 13.0 mm. Fig. 4, *Comitas opulenta* (Thiele). Agulhas Bank, 155 metres, South Africa. 12.5 mm. (Figs. 2, 3 and 4 from Thiele, 1925, pls. 23, 24).



Thiele's holotype, however, is an immature shell of only 13 mm., compared with 43.5 mm. for *palawanica*. Both have the last whorl devoid of tubercles, so an adult of Thiele's species would presumably have more than one of the later whorls smooth. The only other difference of any significance between the two shells is the persistence of a smooth spiral peripheral ridge after the tubercles become obsolete, in the case of *palawanica*, but not in *aequatorialis*.

The considerably less inflated body-whorl of *undosa* is apparently a constant feature, as shown by "Albatross" material from the Molucca Passage in 435 fathoms.

However, when more material is available, the three shells discussed above may prove to be of no greater than subspecific rank.

### *Comitas aequatorialis* (Thiele, 1925)

(Pl. 224, fig. 3)

*Range*—East Africa, off Somali Coast in 1644 metres.

*Remarks*—This species is known to me only from Thiele's figure and brief description. The type, only 13 mm. in height, is almost certainly an immature shell; it does however, appear to closely resemble the subspecies *palawanica*, a much larger shell, described following. Apart from the very considerable size difference between *aequatorialis* and *palawanica*, the latter has many more of the spire-whorls bearing peripheral tubercles, after which the carina continues as a smooth peripheral ridge over the otherwise smooth body-whorl. In *aequatorialis* the plain last whorl is globose and does not have a peripheral carina. The Indonesian *undosa*, which appears to be closely allied also, has the smooth body-whorl similarly ridge margined at the periphery but this whorl is much less inflated than in either *aequatorialis* or *palawanica*.

#### *Measurements (mm.)—*

height	width
13.0	5.0

#### *Synonymy—*

1925 *Leucosyrinx aequatorialis* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped., Bd. 17, Gast. 2, p. 216, pl. 23, fig. 22.

*Types*—The holotype is in the Zoological Museum, East Berlin.

### *Comitas aequatorialis* new subspecies *palawanica* Powell

(Pl. 225, figs. 5, 6)

*Range*—Philippines, Palawan Passage, 515 fathoms, grey mud.

*Remarks*—The subspecies differs from the typical species in having more of the spire-whorls tuberculate, and in the persistence of the peripheral carina as a smooth cord over the body-whorl.

*Description*—Shell narrowly fusiform, 43.5 mm. (1¾ inches) in height, rather thin, white, covered by a very thin, smooth, yellowish-buff periostracum. Whorls 10, including a small smooth papillate protoconch of 1½ whorls. Spire tall and turreted, slightly taller than the height of the aperture plus the canal. Whorls bluntly angled just below the middle. Shoulder slope wide, only slightly concave, and steeply descending. Peripheral carina sculptured with protractively oblique tubercles, about 13 per whorl. These tubercles become obsolete over the body-whorl, but the carina persists as a plain weak keel. Spiral sculpture of from 2-5 weak primary threads on the spire whorls, plus several much weaker intermediates. The base, neck and anterior canal are densely sculptured with weak primary threads and intermediates, but the shoulder slope is smooth except for numerous sinus growth lines. The sinus is moderately deep, U-shaped, its apex a little below middle shoulder slope height. Anterior canal relatively short, obliquely flexed and recurved at the tip. Operculum large, 12 × 5.5 mm., leaf-shaped, with a terminal nucleus (Pl. 213, fig. 2).

#### *Measurements (mm.)—*

height	width
43.5	15.0

*Types*—The holotype is in the United States National Museum, Washington (Albatross Sta. 5350; USNM. 237910).

### *Comitas undosa* (Schepman, 1913)

(Pl. 227, figs. 3, 4)

*Range*—Indonesia, Flores Sea in 794 metres and Molucca Passage.

*Remarks*—The probable relationship of this species both with *aequatorialis* and its new subspecies *palawanica* is discussed above.

*Description*—(original) "Shell elongately fusiform, with rather long canal, rather strong, yellowish-white. Apex wanting, remaining whorls 6½, separated by a conspicuous, simple suture,

convex, slightly excavated at their upper part. Sculpture consisting of numerous, very irregular, spiral striae, more conspicuous at the base of shell and canal, scarcely traceable in the excavation; upper whorls with a peripheral row of obtuse tubercles, which in the uppermost whorls have the character of ribs; these tubercles disappear on last whorl, which has only a more prominent keel-like spiral just below the excavation; the whorls are moreover crossed by numerous growth-lines, strongly curved and conspicuous in the excavation, oblique and sometimes rib-like in the lower part, which produces a wavy appearance of some parts of the shell. Aperture oblong, angular above, ending below in a rather long, broad canal, slightly directed to the left; peristome broken, but according to growth-lines with a deep sinus at the suture, then strongly protracted; columellar margin regularly curved, with a thin layer of enamel, slightly contorted along the canal."

*Measurements (mm.)—*

height	width	
30.0	11.0	holotype
29.75	10.5	Molucca Passage

*Synonymy—*

1913 *Surcula undosa* Schepman, Siboga Exped., vol. 49, pt. 1e, p. 425, pl. 27, fig. 13.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—INDONESIA: Flores Sea, 7° 24'S., 118° 15.2'E., 794 metres, fine grey mud with some radiolariae and diatoms (holotype). Molucca Passage, north west of March Island, 435 fathoms (Albatross Sta. 5619, USNM).

**The subsuturally gemmate series**

***Comitas exstructa* (von Martens, 1903)**

(Pl. 226, fig. 1)

*Range*—Off the Nicobar Islands in 805 metres.

*Remarks*—This species, *Lencosyrinx erica* Thiele, 1925, *Pleurotoma (Brachystoma) sub-suturalis* von Martens, 1902 and *Surcula obtusigemmata* Schepman, 1913, appear from the published descriptions and figures, to be closely allied. They all have a subsutural margining of small but distinct gemmules or crenulations. *Exstructa* appears to be nearest allied to *sub-suturalis*, from which it differs only in having a more rounded periphery and oblique short peripheral axials, not pointed tubercles.

*Description*—Shell small, 24 mm. (ca 1 inch) in height. Whorls 9, including a smooth globular protoconch of about 1¾ whorls. Spire slightly taller than height of aperture plus canal. Post-nuclear whorls firstly with a subsutural series of rounded gemmules, followed by a steeply descending shoulder concavity to a bluntly rounded nodulose peripheral angulation, set just below middle whorl height. The axials are short, vertical to slightly protractive, about 16 per whorl. Spiral sculpture of 1-2 narrowly rounded cords, situated between the peripheral axials and the lower suture, with a third cord half emergent over the last whorl. Rather widely spaced spiral cords continue over the base and neck. Surface crowded with axial growth lines. Sinus broadly and shallowly arcuate, occupying most of the

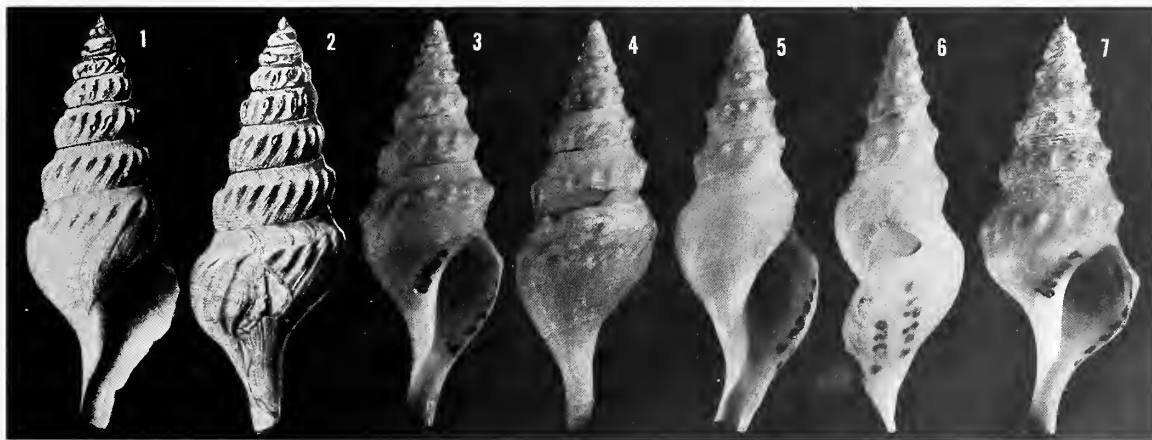


Plate 225. Figs. 1, 2, *Comitas thisbe* (E. A. Smith). East of Ceylon, 1086 fathoms. 44.0 mm. (from Annandale & Stewart, 1909, pl. 20, figs. 1, 2). Figs. 3, 4, *Comitas thisbe diomedea* Powell new subspecies. 49 mm. Holotype, Gulf of Boni, 540 fathoms, Celebes. Figs. 5, 6, *Comitas aequatorialis palawana*

*powell new subspecies*. 43.5 mm. Holotype, Palawan Passage, 515 fathoms, Philippines. Fig. 7, *Comitas luzonica* Powell new species. 42 mm. Holotype, off Mayor Island, 940 fathoms, Luzon, Philippines.

shoulder concavity. Outer lip thin, evidently protractively arcuate.

*Measurements (mm.)—*

height	width
24.0	7.0

*Synonymy—*

- 1903 *Surcula exstructa* von Martens, Gast. deutschen Tiefsee-Exped., Bd. 7, p. 81, pl. 1, fig. 4.  
 1925 *Surcula exstructa* von Martens, Thiele, deutschen Tiefsee-Exped. Bd. 17 no. 2, pl. 35 (23), fig. 21.

***Comitas erica* (Thiele, 1925)**

(Pl. 226, fig. 2)

*Range*—Off Zanzibar and Sumatra in 786 and 750 metres.

*Remarks*—Thiele compared his shell with *Brachytoma subsuturalis* von Martens, from East Africa in 1134 metres, but both that species and *exstructa* von Martens, from off the Nicobar Islands in 805 metres, differ from *erica* in having fewer, stronger, wider-spaced and more evenly developed basal spirals.

*Description*—Shell small, 16.5 mm. ( $\frac{5}{8}$  inch) in height, narrowly fusiform, with tall tabulated spire, narrow aperture and a moderately long slightly flexed unnotched anterior canal. Whorls 9, plus a smooth rounded protoconch of  $1\frac{1}{2}$

whorls. Spire greater than height of aperture plus canal. Post-nuclear whorls firstly with a sub-sutural series of small gemmules, followed by a steeply descending almost straight shoulder area to a rather sharply angled nodulose periphery, set at less than lower third of whorl height. The peripheral nodes continue to the lower suture as slightly protractively oblique folds. These are crossed by three spiral cords which appear prominently on the folds but not in the inter-spaces. Below this, closely spaced spirals cover the body-whorl to the anterior end but only the two uppermost are relatively strong, and one of these is half emergent at the suture. The sinus is indicated as being shallowly broadly arcuate, occupying the whole of the shoulder slope.

*Measurements (mm.)—*

height	width
16.5	7.8

*Synonymy—*

- 1925 *Leucosyrinx erica* Thiele, Gast. deutschen Tiefsee-Exped., Bd. 17, no. 2, p. 236, pl. 36 (24), fig. 25.

*Types*—The holotype is in the Zoological Museum, East Berlin.

*Records*—SUMATRA: off Siburut Island, 750 metres (type locality). ZANZIBAR: 5° 18' 06"S., 39° 24' 12"E., 786 metres (John Murray Exped., Sta. 108, Brit. Mus.).

***Comitas obtusigemmata* (Schepman, 1913)**

(Pl. 227, figs. 1, 2)

*Range*—Indonesia to Arafura Sea, 472-2029 metres, and ? Pratas Islands, South China Sea, 208 fathoms.

*Remarks*—This species is known to me only from the original description and figures, but "Albatross" material from the Pratas Islands is probably the same as Schepman's shell. Schep-

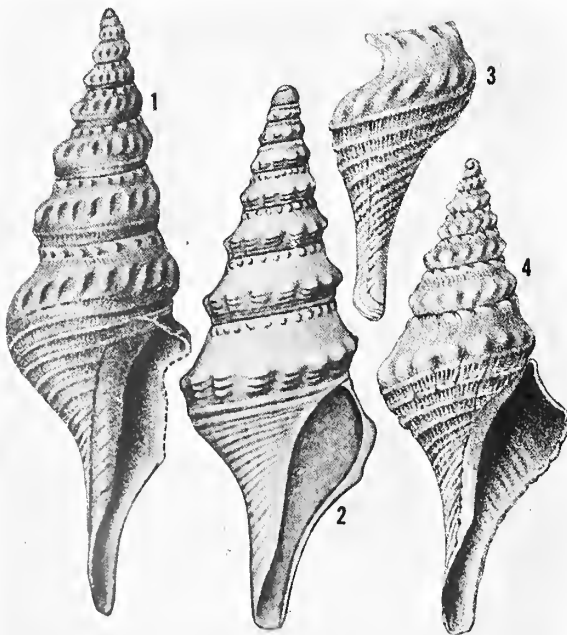


Plate 226. Fig. 1, *Comitas exstructa* (von Martens). Off Nicobar Islands, Bay of Bengal, 805 metres. 24.0 mm. (from von Martens, 1903, pl. 1, fig. 4). Fig. 2, *Comitas erica* (Thiele). Off Sumatra, 750 metres. 16.5 mm. (from Thiele, 1925, pl. 36, fig. 25). Figs. 3, 4, *Comitas subsuturalis* (von Martens). Off East Africa, 1134 metres. 23.0 mm. (from von Martens, 1903, pl. 1, fig. 7).



Plate 227. Figs. 1, 2, *Comitas obtusigemmata* (Schepman). Indonesia, 2029 metres Macassar Strait. 22.5 mm. (from Schepman, 1913, pl. 27, figs. 12a, b). Figs. 3, 4, *Comitas undosa* (Schepman). Indonesia, Flores Sea, 794 metres. 30.0 mm. (from Schepman, 1913, pl. 27, figs. 13a, b).



man suggested alliance of his species with *Brachytoma subsuturalis* Martens, but that species has fewer, more widely spaced and evenly developed basal spirals, as in Martens' other species, *exstructa*. In *obtusigemmata* there are two or three strong upper spiral cords on the base, followed by weaker, more numerous and linear-spaced spirals. The colour quoted by Schepman, yellowish-grey, evidently applies to a dead shell, for fresh Pratas shells are shining pure white. The Pratas specimens differ from Schepman's illustration only in that the peripheral nodes are weaker, but none of the former are fully grown.

*Description*—(original) "Shell broadly fusiform, with pyramidal spire and rather long, slender canal, thin, yellowish-grey. Nucleus of largest specimen wanting . . . (1½ smooth whorls in another example) . . . , remaining whorls 6, not very convex, but apparently so by a row of coarse, obtuse, rounded beads, near the base of upper whorls and the periphery of last whorl, where they are 14 in number; a second row of small tubercles, rounded in upper whorls, having the character of oblique folds on lower ones, runs just below the deep suture, on a subsutural rib; lower on the shell is lirate, 2 faint lirae in the interstices of the peripheral beads, 2 strong ones below the beads of last whorl and numerous fainter ones on base and canal; the shell is covered with very fine growth-lines, last whorl strongly attenuated below. Aperture oval, angular above, ending in a rather long, narrow canal below; peristome thin, with a wide, rather shallow sinus above, then strongly protracted; columellar margin rather straight, directed to the left near and along the canal, with a thin layer of white enamel."

*Measurements (mm.)*—

height	width	
22.5	9.5	holotype
17.0	6.0	Pratas Islands

*Synonymy*—

1913 *Surcula obtusigemmata* Schepman, Siboga Exped., vol. 49, pt. 1e, sect. 5, p. 424, pl. 27, fig. 12.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—INDONESIA: Macassar Strait, 4° 22.1'S., 180° 16.9'E., 2029 metres, fine grey mud; Channel between Makjan and Halmahera, 472 metres, fine dark muddy sand. ARAFURA SEA: 5° 46.7'S., 134° 0'E., 1788 metres, bluish green mud (Schepman). SOUTH CHINA SEA: off Pratas Islands, 208 fathoms (Albatross Sta. 5301, USNM).

*Comitas subsuturalis* (von Martens, 1902)

(Pl. 226, figs. 3, 4)

*Range*—East Africa and off Zanzibar, 818 and 1134 metres.

*Remarks*—This species seems to have more in common with *obtusigemmata* than with the other two members of this group, in that the subsutural margining is crenulate rather than gemmate over the later whorls. Also the basal spirals are of uniform size, widely and evenly spaced in *subsuturalis* but in *obtusigemmata* there are two heavy upper basal spirals, followed by numerous weaker, more closely spaced cords.

*Description*—Shell of moderate size, 23 mm. (1 inch) in height, narrowly fusiform-biconic, with the spire a little less than height of aperture plus canal. Whorls 9, including a smooth subglobose protoconch of two whorls. Post-nuclear whorls firstly with a subsutural narrow fold sculptured with numerous short retractive laterally compressed nodes, followed by a smooth almost flat steeply descending shoulder area to a bluntly rounded tuberculate keel, which occupies the lower third of the whorl height. Tubercles about 15 per whorl, erect to slightly protractive, connected below by a single narrow spiral cord. Base with 4 or 5 rather distant spirals above, uppermost emergent from the subsutural fold, followed by gradually diminishing and more closely spaced spirals over the neck and anterior canal. Sinus of moderate depth, broadly arcuate, occupying most of the shoulder slope and confluent below with the considerable arcuately forwardly produced outer lip.

A related new species from the Gulf of Aden in 1270 metres is white, under a thin pale yellowish periostracum, and the operculum is leaf-shaped with a terminal nucleus.

*Measurements (mm.)*—

height	width
23.0	9.0

*Synonymy*—

1902 *Pleurotoma (Brachytoma) subsuturalis* von Martens, Sitzungsber. d. Gesell. naturf. Freunde, Berlin, p. 239.

1903 *Brachytoma subsuturalis* (Martens), von Martens, Gast. deutschen Tiefsee-Exped., Bd. 7, p. 85, pl. 1, fig. 7.

*Records*—EAST AFRICA: 1° 49'N., 45° 29'E., 1134 metres (type locality). ZANZIBAR: Pemba Channel, 5° 24'S., 39° 19'E., 818 metres (von Martens, 1903).

***Comitas* (sensu lato)****? *Comitas halicyria* (Melvill, 1904)**

(Pl. 220, fig. 4)

*Range*—Gulf of Oman, 24° 49'N., 56° 56'E., 225 fathoms, mud bottom.

*Remarks*—This species, which I have not seen, is known only from the unique holotype in the British Museum. Melvill compared his species both with *undatiruga* Bivona, which is a *Fusiturris*, with a peripheral sinus and very different sculpture, and with *symbiotes* Wood-Mason & Alcock, to which it may bear distant relationship.

*Description*—Shell of moderate size, 32 mm. (1¼ inches) in height, rather thin, fusiform, with tall turreted spire, long body-whorl and moderately long unnotched anterior canal. Whorls 9, including a smooth vitreous globose protoconch. Whorls with a well marked smooth subsutural cord, followed by a lightly concave shoulder area to a sharply angulate periphery at ¾-⅓ whorl height. Sculpture of rounded protractively oblique axial folds, 15 per whorl, which commence abruptly at the periphery but fade out on the base. Surface crossed obscurely, in places, by rather distant weak spiral lirae. Sinus rather shallow, broadly rounded, on the shoulder slope. Colour dull white.

*Measurements* (mm.)—

height	width
32.0	10.0

*Synonymy*—

1904 *Pleurotoma* (*Surcula*) *halicyria* Melvill, Proc. Malac. Soc., vol. 6, p. 164, pl. 10, fig. 16.

*Types*—The holotype is in the British Museum (Natural History).

**? *Comitas laura* (Thiele, 1925)**

(Pl. 224, fig. 2)

*Range*—East Africa, off Kenya, 1° 40.6'S., 41° 47.1'E., in 693 metres.

*Remarks*—This species is known to me only from the original description and figure, which indicate an immature shell.

*Description*—Shell small, 8 mm. (5/16 inch) in height, broadly fusiform, with spire slightly taller than height of aperture plus canal. No subsutural margining, shoulder area wide, straight and steeply descending to a blunt peripheral angle, at lower third of whorl height. Axial sculpture of peripheral nodes, rounded on early

whorls, lengthened below over the last whorl but not quite reaching the lower suture. Spiral sculpture of weak cords, 1-2 emergent between peripheral nodes and lower suture and continued, linear spaced, over the body-whorl to the anterior end, which appears to be smooth. Whorls 6½ of which 1½ form the relatively large globular smooth protoconch, the last whorl faintly angulate. Sinus broadly rounded occupying most of the shoulder slope. Colour light brownish.

*Measurements* (mm.)—

height	width
8.0	3.25

*Synonymy*—

1925 *Surcula laura* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped. vol. 17, Gastr. 2, p. 237, pl. 26, f. 16.

*Types*—The holotype is in the Zoological Museum, East Berlin.

***Comitas opulenta* (Thiele, 1925)**

(Pl. 224, fig. 4)

*Range*—Off South Africa, 155 to about 500 metres.

*Remarks*—This species falls readily into *Comitas* since it is fusiform, with a blunt smooth paucispiral protoconch and post-nuclear sculpture of protractively oblique axials, stopped above by a smooth shoulder area, site of a broad but deeply arcuate sinus.

*Description*—(composite; from Thiele's German description and Barnard's supplementary notes)—Shell small, 12.5 mm. (ca ½ inch) in height, fusiform, spire slightly taller than aperture plus canal. Whorls 6½, including a blunt smooth dome-shaped protoconch of about 1½ whorls. Shoulder area smooth, slightly concave and rather narrow, bounded below at about three fourths whorl height by an angulation formed by the abrupt termination of numerous linear spaced very protractively oblique fold like axials which continue strongly to the lower suture but do not extend over the base. Axials 15 on early whorls, increasing to 18-20 on the body-whorl (Barnard). Spiral sculpture consisting of faint spiral striae, crossing the axials on the spire-whorls and about 8 distinct threads on the neck and anterior end. Colour white.

*Measurements* (mm.)—

height	width
12.5	4.7

**Synonymy—**

1925 *Surcula opulenta* Thiele, Deutschen Tiefsee-Exped., "Valdivia", vol. 17, Gast. 2, p. 226, pl. 24, fig. 15.

1958 *Clavatula (Surcula) opulenta* (Thiele), Barnard, Ann. S. African Mus., vol. 44, p. 144.

**Types**—The holotype is in the Zoological Museum, East Berlin.

**Records**—SOUTH AFRICA: Agulhas Bank, 155 metres (type locality); off Cape Point, 230 fathoms (Barnard).

**Indian Tertiary Species*****Comitas kayalensis* (Dey, 1962)**

(Pl. 228, fig. 1)

**Range**—Miocene of Quilon, Kerala, India.

**Remarks**—This species appears from the description and figures to be a *Comitas* rather than a *Turricula*. It is *Fusinus*-like, with rather sparse heavy axial folds, 6-8 per whorl, subobsolete over the shoulder slope but strong medially, and overridden by primary cords and secondary threads.

**Description**—(original)—Shell of medium size, fusiform; spire elevated, its height equal to that of the aperture and canal combined; protoconch small, smooth, blunt, probably consisting of 2 whorls; subsequent whorls 9, compressed at the suture, increasing rapidly in size, ornamented with both axial ribs and spiral lines; the axials are strongly swollen and conspicuous at the periphery, but absent on the wide area in front of the suture; they number 8 on the body-whorl; overriding them are primary and secondary spiral threads, the number of which increases with the growth of the shell; on the penultimate whorl there are about 5 primary threads; suture bordered by a narrow and delicately crenulate spiral cord, in front of which is a wide concave area bearing indistinct spiral lines and strong growth-lines, concave towards the aperture; aperture lenticular; anterior canal long, slightly oblique; parietal wall callused; outer lip broken away."

**Measurements (mm.)—**

height	width
47.0	17.0

**Synonymy—**

1962 *Turricula kayalensis* Dey, Memoirs Geol. Surv. India. Pal. Indica, n.s., vol. 36, p. 94, pl. 8, figs. 3, 4.

**Types**—The holotype is in the collection of the Geological Survey of India, Calcutta.

**Indonesian Tertiary Species*****Comitas dijki* (K. Martin, 1884)**

(Pl. 208, figs. 1, 2)

**Range**—Java at Grissee, bore No. 1 at 466 metres (type locality), upper Miocene.

**Remarks**—This shell, judged solely from the description and figure, seems without doubt to be a *Comitas*. It is elongate-fusiform with tall spire, subequal in height to that of the aperture plus the moderately long, slightly flexed anterior canal. The sculpture is of bold narrowly crested rather flexuous axials, which extend from suture to suture and continue over most of the base. These are crossed, on the spire-whorls by two moderately strong spiral cords, one at the weak peripheral angle, at two thirds whorl height, the other midway between the periphery and the lower suture. These cords are strongest in the interstices and do not form gemmules at their weak intersection with the axials. The suture is noticeably waved by the axials.

**Synonymy—**

1884 *Pleurotoma (Surcula) dijki* K. Martin, Tiefbohr. auf Java, Samml. Reichs-Mus., Leiden, vol. 3, p. 62, pl. 4, fig. 62.

1919 *Surcula dijki* (Martin), Martin, Palaeozool. Kenntnis von Java, p. 74.

1931 *Surcula dijki* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

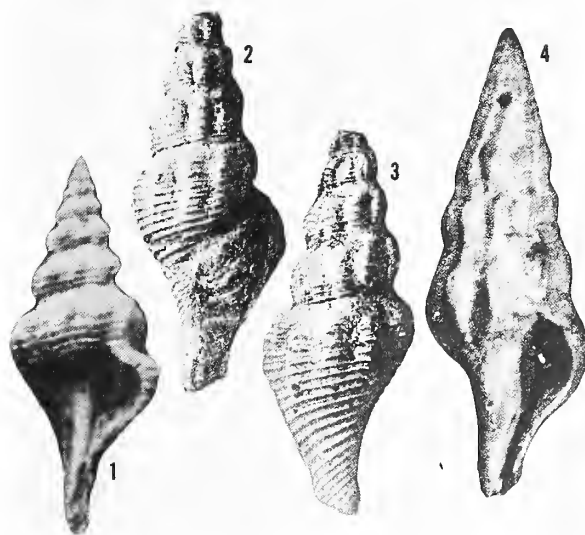


Plate 228. Fig. 1, *Comitas kayalensis* (Dey). Miocene of Quilon, Kerala, India. 47.0 mm. (from Dey, 1962, pl. 8). Figs. 2, 3, *Comitas sobrina* (Yokoyama). Dainichi Pliocene of Japan. About 36 mm. (from Yokoyama, 1923, pl. 1, fig. 1). Fig. 4, *Comitas hillegondae* (K. Martin). Nanggulan Miocene of Kali Puru, Java. 19.0 mm. (from K. Martin, 1931, pl. 1, fig. 15).



**? *Comitas buxtorfi* (K. Martin, 1914)**

(Pl. 229, figs. 5, 6)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java.

*Remarks*—The generic location of this narrowly fusiform shell of 20 mm. ( $\frac{3}{4}$  inch) in height, is doubtful. It could be either a *Turricula* or a *Comitas*, with leanings toward the former, on account of the prominent spiral sculpture, overriding the sparse but strong fold-like axials. On the other hand the broadly conical protoconch of  $2\frac{1}{2}$  smooth whorls, medially subcarinate towards its close, and followed by a half whorl of brephic axials suggests *Comitas*.

*Measurements (mm.)—*

height	width
20.0	—

*Synonymy—*

- 1914 *Surcula buxtorfi* Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2, no. 4, p. 114, pl. 1, figs. 11, 12.  
 1919 *Surcula buxtorfi* Martin, Palaeozool. Kenntnis von Java, Leiden, p. 74.  
 1931 *Surcula buxtorfi* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 219.

***Comitas hillegondae* (K. Martin, 1931)**

(Pl. 228, fig. 4)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java.

*Remarks*—So far as can be judged from the

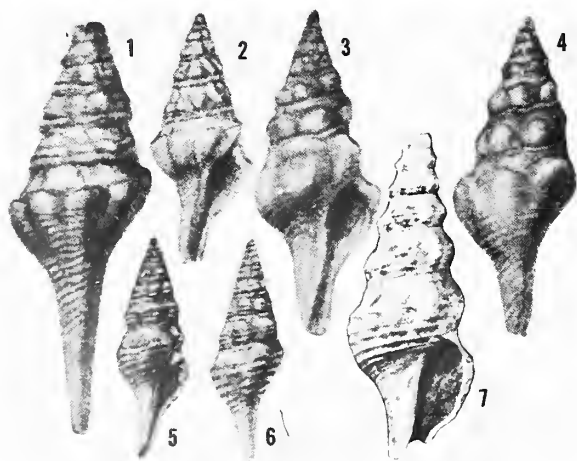


Plate 229. Figs. 1, 2, *Comitas mordax* (K. Martin). 23.0 mm. Figs. 3, 4, *Comitas mertoni* (K. Martin). 20.0 mm. Figs. 5, 6, *Comitas buxtorfi* (K. Martin). 20.0 mm. (all Nanggulan Miocene of Kali Puru, Java; from K. Martin, 1914, pl. 1). Fig. 7, *Comitas miyazakiensis* Shuto, Takanabe Lower Pliocene of Japan (from Shuto, 1961, pl. 10, fig. 16). 22.6 mm.

indistinct figure of this species it conforms with *Comitas* rather than with *Turricula*.

This species must not be confused with *Surcula hillegondae* Martin, 1914, which appears to be happily placed in *Turricula*.

*Description*—Shell rather small, 19 mm. ( $\frac{3}{4}$  inch) in height, narrowly fusiform, with a tall spire, almost  $1\frac{1}{2}$  times the height of the aperture plus the canal. Sculpture of rather widely spaced, vertical, bold, broadly rounded axials, which are subobsolete over the shallow, rather wide, steeply descending shoulder slope. The broadly rounded peripheral subangle is at about the lower third of whorl height, which gives the shell a sagged look. Subsutural fold weak. Whole surface of the shell with linear-spaced spiral lirae which override the axials. Base deeply contracted to an anterior canal of moderate length.

*Synonymy—*

- 1931 *Pleurotoma hillegondae* Martin, Wetens. Meded. Mijnb. Ned.-Indie, No. 18, p. 7, pl. 1, fig. 15.  
 1931 *Pleurotoma hillegondae* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 218.

***Comitas mertoni* (K. Martin, 1914)**

(Pl. 229, figs. 3, 4)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java.

*Remarks*—This appears to be a *Comitas* rather than a *Turricula*; 20 mm. ( $\frac{3}{4}$  inch) in height; notable for its few strong boss-like axials, 6-7 per whorl. The suture is submargined by a narrow but distinct smooth undulating rounded cord. The spiral sculpture is of distinct linear spaced cords which commence at the termination of the rather narrow concave shoulder sulcus and continue below over the base and straight moderately long anterior canal. The spirals do not appear to override the peripheral axials, but are prominent in their interstices.

*Measurements (mm.)—*

height	width
20.0	—

*Synonymy—*

- 1914 *Surcula mertoni* K. Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2 no. 4, p. 115, pl. 1, figs. 14, 15.  
 1919 *Surcula mertoni* Martin, Palaeozool. Kenntnis von Java, Leiden, p. 74.  
 1931 *Surcula mertoni* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

**Comitas mordax (K. Martin, 1914)**

(Pl. 229, figs. 1, 2)

*Range*—Nanggulan Beds, Miocene of Kali Puru, Java.

*Remarks*—This is another problematic species with leanings towards *Comitas* rather than towards *Turricula*. It is a narrowly fusiform shell of up to 23 mm. in height, and has a tall spire as well as a relatively long straight tapered anterior canal. The sculpture is of broadly rounded fold-like axials, especially broad at the periphery, where they abruptly terminate, forming a sharp undulated lower edge to the smooth shoulder sulcus, which is margined at the upper suture by a strong smooth rounded cord. The only other spiral sculpture is in the form of closely spaced distinct spiral cords on the body-whorl, commencing a little distance down from the crest of the axials.

Martin's fig. 22 was named (p. 117) as a new variety, *cuspidata*, but without seeing the original material it is difficult to evaluate this shell. At first sight of the figure a very different form of shell is suggested, but the quickly accelerated spire whorls and relatively short anterior canal are possibly resultant from shell injury, which is indicated in the figure. For the present, *cuspidata* is included in the synonymy of the species.

*Measurements (mm.)—*

height	width
23.0	—

*Synonymy—*

1914 *Surcula mordax* Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2 no. 4, p. 116, pl. 1, figs. 18-21; var. *cuspidata*, fig. 22.

1919 *Surcula mordax* Martin, Palaeozool. Kenntnis von Java, p. 74.

1931 *Surcula mordax* Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 220

**Japanese Tertiary Species*****Comitas habei* Shuto, 1961**

(Pl. 230, fig. 3)

*Range*—Japan, lowest Pliocene.

*Remarks*—This is a typical *Comitas* and nothing to do with the Miocene to Recent, West Mexican and Caribbean *Fusiturricula*, which was used subgenerically for this species and *miyazakiensis* by Shuto.

*Description*—Shell of moderate size, 29 mm. (1 $\frac{1}{8}$  inches) in height, solid, narrowly fusiform,

with tall turreted spire, about 1 $\frac{1}{4}$  times height of aperture plus moderately long canal. Whorls about 11, including a small smooth globose protoconch of two whorls, the tip depressed and oblique. Axial sculpture of prominent broadly rounded folds, 10-13 per whorl, which extend from the bluntly rounded median angle to the lower suture. Suture adpressed, rather broadly, but weakly submargined, followed by a moderately wide concave shoulder area. Spiral sculpture of moderately strong cords from the peripheral angle to the neck, weaker to subobsolete elsewhere. Anal sinus U-shaped, moderately deep, occupying most of the shoulder area, its apex narrowly rounded, closer to the angulation than to the suture.

*Measurements (mm.)—*

height	width
29.0	9.55

*Synonymy—*

1961 *Comitas (Fusiturricula) habei* Shuto, Mem. Fac. Sci. Kyushu Univ., ser. D, Geol. vol. 11, 2, p. 95, pl. 7, figs. 15, 19, pl. 9, fig. 1, text figs. 5, 6.

*Types*—The holotype is in the Department of Geology, Kyushu University, Japan.

*Records*—JAPAN: road cutting, Hagenoshita, Uwaye, mura, Koyu gun, Miyazaki Prefecture (lower Takamabe member, lowest Pliocene).

**? *Comitas makiyamai* (Shuto, 1961)**

(Pl. 231)

*Range*—Lower Pliocene of Miyazaki, Japan.

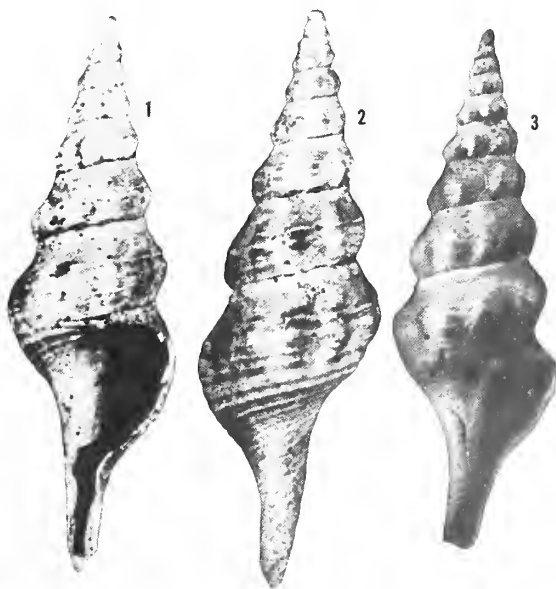


Plate 230. Figs. 1, 2, *Comitas miyazakiensis* Shuto. Lower Pliocene of Japan. 22.6 mm. (from Shuto, 1961, pl. 5, figs. 1, 4). Fig. 3, *Comitas habei* Shuto. Lower Pliocene of Japan. 29.0 mm. (from Shuto, 1961, pl. 7, fig. 15).



Plate 231. *Comitas makiyamai* (Shuto). Roadside cutting at Hagenoshita, Uwaye mura, Koyu gun, Japan, lowest Pliocene. 10.3 mm. Holotype (two views) and paratype (from Shuto, 1961, Mem. Fac. Sci. Kyushu Univ., ser. D, Geol. 11 (2), pl. 7, figs. 16, 10, 6).

**Remarks**—This species may not be satisfactorily located in *Comitas*, but on the other hand it is quite remotely dissimilar from *Cosmasyrinx*, its original location.

**Description**—Shell narrowly fusiform, small, 8–10.3 mm. (about  $\frac{3}{8}$  of an inch) in height, with a tall spire of greater height than that of the aperture plus the anterior canal. Protoconch relatively large, bluntly rounded, smooth, of two whorls, the last quarter whorl with many coarse oblique brephic axials. Post-nuclear whorls six, all conspicuously carinated at middle whorl height. The suture is subobsoletely submargined, the rest of the shoulder slope is smooth, and the peripheral carina is studded with rather distant strong pointed tubercles that finally more or less resolve into a smooth flange. Below the periphery and on the base and anterior end there are distinct linear-spaced smooth spiral cords. There is also a conspicuous bluntly rounded subangle on the upper part of the base. The sinus is moderately deep, broadly U-shaped, occupying about three-fourths of the shoulder area.

**Measurements (mm.)—**

height	width	
10.3	6.1	holotype
8.2	5.0	paratype

**Synonymy—**

1961 *Cosmasyrinx makiyamai* Shuto, Me. Fac. Sci. Kyushu Univ., ser. D, Geol., vol. 11, no. 2, p. 98, pl. 7, figs. 6, 10, 16.

**Records**—JAPAN: roadside cutting at Hagenoshita, Uwaye mura, Koyu gun, Miyazaki Prefecture, lower part of the Takanabe member, lowest Pliocene.

***Comitas miyazakiensis* Shuto, 1961**

(Pl. 230, figs. 1, 2; Pl. 229, fig. 7)

**Range**—Japan, lower Pliocene.

**Description**—Shell rather small, 22.6 mm. ( $\frac{7}{8}$  inch) in height, solid, narrowly fusiform, with tall spire, about 1 and 1 sixth times height of aperture plus moderately long canal. Whorls 9, including a moderately inflated smooth protoconch of two whorls, the first rather large and depressed. Whorls slightly angulate just below the middle. Suture adpressed, very indistinctly submargined, followed by a wide slightly concave steeply descending shoulder area. Axial sculpture of broad, low axial folds, 10–11 per whorl, extending from just above the angle, to the lower suture. Spiral sculpture of rather strong cords from the angle to the neck, followed by weaker spirals to the end of the anterior canal. The spirals override the axials and thicken at their crests. Anal sinus broadly U-shaped, deep, its apex on the shoulder slope, closer to the angulation than to the suture.

**Measurements (mm.)—**

height	width
22.6	7.1

**Synonymy—**

1961 *Comitas (Fusiturricula) miyazakiensis* Shuto, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol. vol. 11, 2, p. 96, pl. 5, figs. 1, 4, pl. 10, fig. 16, text figs. 5, 6.

**Types**—The holotype is in the Department of Geology, Kyushu University.

**Records**—JAPAN: road cutting at Nihonmatsu, Takanabe machi (type locality); S. E. cliff of Kizukume Hill, Tondamachi, Koyu gun, Miyazaki Prefecture (Takanabe member, lower Pliocene).

***Comitas sobrina* (Yokoyama, 1923)**

(Pl. 228, figs. 2, 3)

**Range**—Dainichi Pliocene of Japan.

**Remarks**—Although the apical whorls are missing the adult facies of the shell strongly suggests *Comitas*.

**Description**—Shell elongate-fusiform, of moderate size, 36+ mm. (1½ inches) in height. Spire tall and narrow and body-whorl excavated over the base to a moderately long, slightly flexuous canal. Apical whorls missing in the type material but the spire appears to be of equal height to that of the aperture plus the canal. Axial sculpture of strong bluntly rounded slightly oblique folds, 10–12 per whorl, and becoming obsolete over the shoulder area and the lower part of the base. Spiral sculpture of numerous narrow cords which



override the axials, and are about 7-10 on the spire whorls, then continued strongly over the base, neck and canal; several threads in each interspace.

*Measurements (mm.)—*

height	width
36.0 (estimated)	13.0

*Synonymy—*

1923 *Drillia sobrina* Yokoyama, Journ. Coll. Sci. Imper. Univ. Tokyo, vol. 45 no. 2, p. 5, pl. 1, fig. 1.

1935 *Turricula sobrina* (Yokoyama), Nomura, Sci. Rep. Tohoku Imper. Univ., Sendai, Japan, Ser. 2, Geol., vol. 18 no. 2, p. 116.

1952 *Turricula (Surcula) sobrina* (Yokoyama), Hatai & Nisiyama, Sci. Rep. Tohoku Univ., Sendai, Japan, Ser. 2, Geol., Spec. vol. No. 3, p. 191.

*Records—JAPAN:* Totomi (type locality); valley, north west of Dainichi (Dainichi, Pliocene).

***Comitas sobrinaeformis* (Nomura, 1937)**

*Range—*Japan, lower or middle Pliocene of Tonohama.

*Remarks—*The author of this species considered its generic position doubtful but referred it provisionally to *Turricula*, and remarked that "it somewhat resembles *T. sobrina* (Yokoyama) and *T. kamakurana* (Pilsbry) from Japan. However the present species differs from the two above mentioned forms, not only in its outline but also in sculpture".

Although the apical whorls are missing, the general facies, the style of sculpture in particular, suggests *Comitas* as the most likely genus. From *sobrina*, this species is distinguished by its more broadly fusiform shape and more numerous axial folds.

*Measurements (mm.)—*

height	width
26.2 (incomplete)	12.3

*Synonymy—*

1937 *Turricula sobrinaeformis* Nomura, Jap. Journ. Geol. & Geogr., vol. 14, p. 89, pl. 6, figs. 7a-c.

***Comitas atsukoe* (Kamada, 1962)**

*Range—*Japan, Nakoso City, Kokozura formation, Miocene.

*Remarks—*This is a clavinid-like shell, with a tall narrow spire and a truncated anterior end. The shoulder slope is steep, moderately wide, the peripheral angle slight and the sculpture is of strong protractively oblique axials, which extend from the periphery to the upper part of the base, 10-12 per whorl. The protoconch is described as of three smooth rounded whorls and the posterior sinus is indicated as lying just above the angle.

The rather scant original description and small indistinct figures suggest *Comitas* as the most likely genus, but critical comparison with other species is impossible without recourse to type material.

*Measurements (mm.)—*

height	width
21.0	7.5
21.0	8.0

*Synonymy—*

1962 *Turricula atsukoe* Kamada, Palaeont. Soc. Japan, Spec. Papers, no. 8, p. 176, pl. 20, figs. 14-17.

**Group of *Comitas clarae* Tenison-Woods**

For this group of Tertiary species the writer proposed *Carinacomitas* (1942, Bull. no. 2, Auck. Inst. Mus., p. 60), on the basis of a carinated protoconch, as opposed to the supposed non-carinated apex of typical *Comitas*. However it has since been pointed out, firstly by Vella (1954, Trans. Roy. Soc. N. Z., 81 (4), p. 548) and later by Marwick (1965, N. Z. Geol. Surv. Pal. Bull. 39, p. 42), that the protoconch of *fusiformis*, type of *Comitas*, varies from globose to sharply keeled, and so *Carinacomitas* must be considered a synonym of the typical genus.

***Comitas aldingensis* Powell, 1944**

(Pl. 222a, fig. 5)

*Locality*—SOUTH AUSTRALIA: Aldinga, lower beds (upper Eocene)

***Synonymy*—**

1944 *Comitas* (*Carinacomitas*) *aldingensis* Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 18, pl. 1, fig. 7.

*Type*—The holotype is in the Auckland Museum.

***Comitas clarae* (Tenison-Woods, 1880)**

*Locality*—VICTORIA: Muddy Creek, lower beds (middle Miocene)

***Synonymy*—**

1880 *Pleurotoma clarae* Tenison-Woods, Proc. Linn. Soc. N. S. W., vol. 4, p. 11, pl. 3, fig. 11.

1944 *Comitas* (*Carinacomitas*) *clarae* (Tenison-Woods), Powell, Rec. Auck. Inst. Mus., vol. 3 no. 1, p. 19.

***Comitas subcarinapex* Powell, 1942**

(Pl. 222a, fig. 4)

*Locality*—NEW ZEALAND: Clifden, 6c, Southland (Clifdenian, lower Miocene)

***Synonymy*—**

1942 *Comitas* (*Carinacomitas*) *subcarinapex* Powell, Bull. no. 2, Auck. Inst. Mus., p. 60, pl. 10, fig. 5.

*Type*—The holotype is in the Auckland Museum.

by moderately strong spiral cords, but the protoconch differs, as described above, by being narrowly conical and polygyrate.

*Description*—Shell small, 12.4 mm. ( $\frac{1}{2}$  inch) in height, rather solid, fusiform, with a tall spire, and a long, almost straight, anterior canal. Sculpture consisting of regular rounded axial folds, subobsolete over the wide shoulder sulcus, overridden by strong spiral cords, one subsutural, 3 from the periphery to the lower suture, continued over the base to the anterior canal, and with a few secondary spirals only, in the shoulder sulcus.

*Measurements (mm.)*—

height	width
12.40	5.05

*Synonymy*—

1969 *Pleurofusua* (*Pseudofusua*) *dinglensis* Shuto, Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., vol. 19, no. 1, p. 189, pl. 14, figs. 7, 9, 11; pl. 21, figs. 11, 18; text figs. 34, 37.

*Types*—The type material is in the Department of Geology, Kyushu University, Japan.

**Subgenus *Pseudofusua* Shuto, 1969**

*Type: Comitas* (*Pseudofusua*) *dinglensis* Shuto, 1969

Shell very similar to *Comitas* in its adult form, but with a protoconch that is tall, conical, of four smooth, lightly convex whorls, while that of *Comitas* is smooth, but paucispiral, papillate, of only two whorls, the last more or less subcarinate.

Shuto made his *Pseudofusua* a subgenus of *Pleurofusua*, the type of which is an Eocene shell from the southern United States. *Pleurofusua* has a small smooth paucispiral protoconch, but the adult shell is more *Fusinus*-like, with many broadly-rounded, boss-like, axial folds, with a tall narrow spire, and with a rather long straight anterior canal. I place the subgenus under the genus *Comitas*. The type species of *Pseudofusua* is a Neogene shell from the Island of Panay, Philippines.

*Synonymy*—

1969 *Pseudofusua* Shuto, Memoirs of the Faculty of Science, Kyushu University, series D, Geology, vol. 19, no. 1, p. 188. Type by original designation: *Pleurofusua* (*Pseudofusua*) *dinglensis* Shuto, 1969.

***Comitas* (*Pseudofusua*) *dinglensis* (Shuto, 1969)**

(Pl. 231a)

*Range*—Panay Island, Philippines, upper part of Dingle Formation, Neogene.

*Remarks*—This species resembles the New Zealand Miocene *Comitas fusiformis* (Hutton) in its adult facies of strong axial folds, overridden

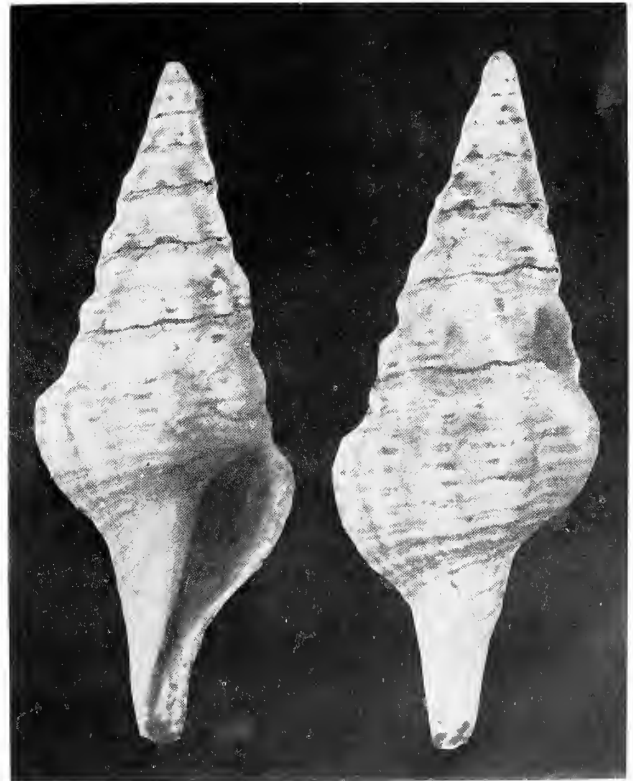


Plate 231a. *Comitas* (*Pseudofusua*) *dinglensis* (Shuto), Panay Island, Philippines, Dingle Formation, Neogene. Holotype, 12.4 mm. (from Shuto, 1969, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol., vol. 19, no. 1, pl. 14, figs. 7, 11)



***Anticomitas vivens* Powell, 1942**

(Pl. 232; Pl. 212, fig. 3)

*Locality*—New Zealand: off the Three Kings Islands, 140 fathoms. Type (unique), in the writer's collection, Auckland Museum.

***Synonymy*—**

1942 *Anticomitas vivens* Powell, Bull. 2, Auck. Inst. Mus., p. 61, pl. 10, fig. 11.

**Genus *Anticomitas* Powell, 1942**

*Type: Anticomitas vivens* Powell, 1942

This genus was founded for the reception of a sole New Zealand Recent species which resembles *Comitas* but has a very depressed smooth protoconch of 2½ whorls, the last whorl of which is strongly and sharply carinated. Adult shell small (9.5 mm.), with a tall spire but a relatively short, obliquely shallowly notched anterior canal. Sinus broad and shallow, occupying the shoulder area and not restricted by any subsutural band or margining. Sculpture of heavy blunt axials crossed by moderately strong spiral cords.

*Range*—Recent, northernmost New Zealand.

***Synonymy*—**

1942 *Anticomitas* Powell, The New Zealand Recent and Fossil Mollusca of the Family Turridae, Bull. 2, Auck. Inst. Mus., p. 61. Type by original designation: *Anticomitas vivens* Powell, 1942.



Plate 232. *Anticomitas vivens* Powell. New Zealand, off the Three Kings Islands in 140 fathoms. 9.5 mm. (from Powell, 1942, pl. 10, fig. 11).

**Paracomitas gemmea (Murdoch, 1900)**

*Locality*—New Zealand: blue-clays cliffs west of Wanganui Heads (Castlecliffian, Pleistocene).

*Synonymy*—

1900 *Pleurotoma gemmea* Murdoch, Trans. N. Z. Inst., vol. 32, p. 217, pl. 20, fig. 9.

**Paracomitas gypsata (Watson, 1881)**

*Locality*—New Zealand: east of East Cape, 700 fathoms. The type is in the British Museum (Natural History).

*Synonymy*—

1881 *Pleurotoma (Drillia) gypsata* Watson, Journ. Linn. Soc., vol. 15, p. 413.

1942 *Paracomitas gypsata* (Watson), Powell, Bull. 2, Auck. Inst. Mus., p. 62.

**Paracomitas protransenna (Marshall & Murdoch, 1923)**

*Locality*—New Zealand: Waikopiro, Block 10, Takapanu S. D., 4 mi. S. E. of Ormondville (Nukumarian, lower Pleistocene).

**Genus Paracomitas Powell, 1942**

*Type*: *Surcula castlecliffensis* Marshall & Murdoch, 1919.

Typically this is a New Zealand Pleistocene to Recent genus. It was employed recently to receive a Miocene-Pliocene species from Okinawa but it is doubtful if there is true relationship.

From *Comitas*, the genus *Paracomitas* differs in the initial whorl of the 2½ whorled protoconch being depressed dome-shaped, not bulbous, (Pl. 212, fig. 5) and all the nuclear whorls are sharply carinate. Adult sculpture of flat-topped spiral cords, beaded at the peripheral angle by numerous weak oblique axials and typically with a second angulation on the body-whorl, proceeding from the suture and defined by a heavier smooth spiral cord.

*Synonymy*—

1942 *Paracomitas* Powell, The New Zealand Recent and Fossil Mollusca of the Family Turridae, Bull. 2, Auck. Inst. Mus., p. 61. Type by original designation: *Surcula castlecliffensis* Marshall & Murdoch, 1919.

**Paracomitas augusta (Murdoch & Suter, 1906)**

*Locality*—New Zealand: 110 fathoms off Great Barrier Island. The type is in the Dominion Museum, Wellington.

*Synonymy*—

1906 *Pleurotoma (Leucosyrinx) augusta* Murdoch & Suter, Trans. N. Z. Inst., vol. 38, p. 286, Pl. 22, figs. 14-17.

1913 *Turris augusta* (Murdoch & Suter), Suter, Manual N. Z. Moll., p. 472.

1942 *Paracomitas augusta* (Murdoch & Suter), Powell, Bull. 2, Auck. Inst. Mus., p. 62.

**Paracomitas castlecliffensis (Marshall & Murdoch, 1919)**

(Pl. 233, fig. 1)

*Locality*—New Zealand: Castlecliff, Wanganui (Castlecliffian, Pleistocene).

*Synonymy*—

1919 *Surcula castlecliffensis* Marshall & Murdoch, Trans. N. Z. Inst., vol. 51, p. 255, pl. 21, fig. 3.

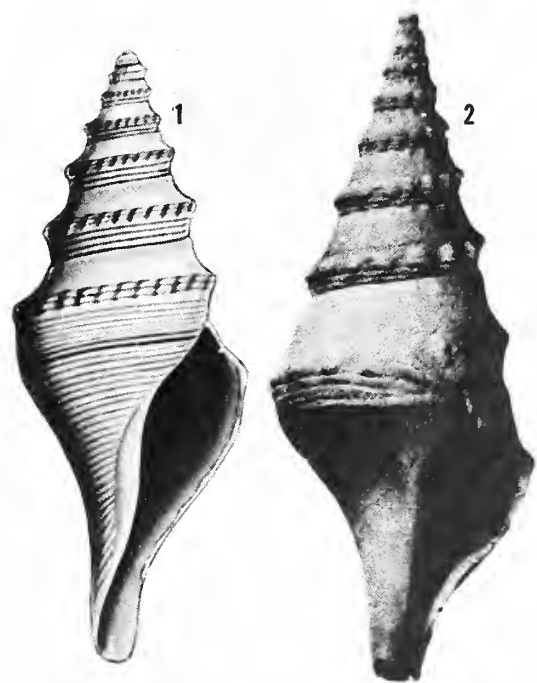


Plate 233. Fig. 1, *Paracomitas castlecliffensis* (Marshall & Murdoch). New Zealand, Castlecliff, Wanganui, Pleistocene. 15.0 mm. (from Powell, 1942, pl. 10, fig. 1). Fig. 2, *Paracomitas? rodgersi* MacNeil. Shinzato tuff, Miocene or Pliocene of Okinawa. 27 mm. (from MacNeil, 1960, pl. 9, fig. 17).

*Synonymy*—

1923 *Surcula protransenna* Marshall & Murdoch, Trans. N. Z. Inst., vol. 54, p. 126, pl. 12, fig. 6.

1942 *Paracomitas protransenna* (Marshall & Murdoch), Powell, Bull. 2, Auck. Inst. Mus., p. 62.

**? *Paracomitas rodgersi* MacNeil, 1960**

(Pl. 233, fig. 2)

*Remarks*—The generic location of this species is provisional. The author compared it with both *Paracomitas castlecliffensis* and *Comitas allani* but noted the atypical protoconch which is small, subnaticoidal and only the last quarter turn is slightly angulate, not carinate.

MacNeil (1960, p. 106) mentioned a closely related Recent species from the Gulf of Boni, 484 fathoms, Celebes, but I have not seen this material.

*Description (original)*—“Shell of medium size and inflation, whorls nearly straight sided, interrupted mainly by the nodose peripheral carina. Protoconch small, subnaticoidal and tilted. Aperture moderately narrow, about half the length of the shell. Outer lip thin, broken on the specimens at hand, but shown by growth lines to recurve sharply into the anal sinus. Anal sinus

moderately broad and deep, adjacent to the suture, the growth lines recurving only slightly from the apex of the sinus to the suture. Sculpture consisting of short axial nodes on the periphery, about ten of the peripheral nodes visible from an angle; lower part of body whorl and columella bearing weak raised spirals which are wider near the periphery, narrower and nearly obsolete on the columella; peripheral nodes crossed by both the spiral sculpture and diagonal lines of growth; subsutural slope smooth and flat except for lines of growth marking former positions of the anal sinus, and the small tubercles or wrinkles just below the suture on the juvenile whorls.”

*Measurements (mm.)*—

height	width	
27.0	11.4	(holotype)

*Synonymy*—

1960 *Paracomitas rodgersi* MacNeil, U. S. Geol. Surv. Prof. Paper 339, p. 106, pl. 9, fig. 17.

*Types*—The holotype is in the United States National Museum, Washington.

*Records*—OKINAWA: Shinzato tuff member (Miocene or Pliocene).



### Genus *Antimelatoma* Powell, 1942

Type: *Drillia maorum* E. A. Smith, 1877

This genus, originally located in the *Clavinae*, is now considered to have more in common with the *Turriculinae*. The most significant non clavineid character is the simple parietal callus, without an entering pad or tubercle.

The shells are small, 14-18 mm. in height, narrowly fusiform, with tall spire and moderately long unnotched slightly flexed anterior canal. The sinus is broad, retracted to a rather narrowly U-shaped apex, which is just below the middle of the shoulder slope. The protoconch is blunt, paucispiral, of slightly more than two whorls; first smooth and dome-shaped, second with four distinct spiral cords.

The sculpture of the post-nuclear whorls consists of prominent fold-like axials, restricted to the area between the peripheral angle and the lower suture, and rather strong spiral cords which override the axials.

The style of protoconch, with its second whorl of strong spiral cords (Pl. 212, fig. 4) is different from that of *Turricula* and also from that of *Comitas*, both of which exhibit some form of axial sculpture at the close of the nuclear whorls.

The operculum is leaf shaped, with a terminal nucleus, and the radula of modified wish-bone type, consisting of a pair of marginals in which one of the basal limbs is severed.

Range—New Zealand, lower Pleistocene (Nukumaruan) to Recent.

The list of eight South Australian species referred to *Antimelatoma* by Cotton (1947, Field Nat. Sect. Roy. Soc. S. Aust. Conch. Club. Publ. No. 4, p. 11) comprises an assortment of clavineid genera. For the most part Cotton merely transferred Hedley's "*Melatoma*" species to *Antimelatoma*, which genus, so far as is known, does not occur outside New Zealand waters.

#### Synonymy—

1942 *Antimelatoma* Powell, Bull. No. 2, Auck. Inst. Mus., p. 97. Type by original designation: *Drillia maorum* E. A. Smith, 1877.

### *Antimelatoma ahiparana* Powell, 1942

(Pl. 234, fig. 1)

Range—New Zealand, off Ahipara, 23 fathoms, Northland (Aupourian marine province).

#### Synonymy—

1942 *Antimelatoma ahiparana* Powell, Bull. No. 2, Auck. Inst. Mus., p. 98, pl. 2, fig. 11.

1966 *Antimelatoma ahiparana* Powell, Bull. No. 5, Auck. Inst. Mus., p. 10, text fig. 38 (radula)

Types—The holotype is in the Powell collection, Auckland Museum.

### *Antimelatoma benthicola* Powell, 1942

Range—New Zealand, off Otago Heads, 50-70 fathoms.

#### Synonymy—

1942 *Antimelatoma benthicola* Powell, Bull. No. 2, Auck. Inst. Mus., p. 98, pl. 2, fig. 10.

Types—The holotype is in the Auckland Museum.

### *Antimelatoma buchanani* (Hutton, 1873)

Range—New Zealand, Wanganui, Napier and Dannevirke (lower Pleistocene, Nukumaruan to upper Pleistocene, Castlecliffian). Type locality, "Shakespeare Cliff" = Castlecliff, Wanganui.



Plate 234. Fig. 1, *Antimelatoma ahiparana* Powell. New Zealand, 23 fathoms off Ahipara. 12.7 mm. Figs. 2, 3, *Antimelatoma buchanani maorum* (E. A. Smith). New Zealand, 5-6 fathoms, Tryphena, Great Barrier Island. 16 mm.

*Synonymy*—

- 1873 *Pleurotoma buehanani* Hutton, Cat. Tert. Moll. N. Z., p. 4.  
1893 *Pleurotoma buehanani* Hutton, Macleay Mem. Vol. Plioc. Moll., pl. 6, fig. 26.  
1942 *Antimelatoma buehanani* (Hutton), Powell, Bull. No. 2, Auck. Inst. Mus., p. 97, text figs. C. 10, F. 2.

*Types*—The holotype is in the New Zealand Geological Survey, Wellington.

***Antimelatoma buehanani subspecies  
maorum* (E. A. Smith, 1877)**

(Pl. 234, figs. 2, 3)

*Range*—New Zealand, the Aupourian marine province from Auckland, northwards.

*Synonymy*—

- 1877 *Drillia?* *maorum* E. A. Smith, Ann. Mag. Nat. Hist., ser. 4, vol. 19, p. 497.  
1913 *Drillia buehanani maorum* (Smith), Suter, Manual N. Z. Moll., p. 474; Atlas (1915), pl. 46, fig. 22.  
1942 *Antimelatoma buehanani maorum* (Smith), Powell, Bull. no. 2, Auck. Inst. Mus., p. 97.

*Types*—The holotype is in the British Museum (Natural History).

***Antimelatoma canyonensis* Dell, 1956**

*Range*—New Zealand, off Eastern Otago, 266–350 fathoms.

*Synonymy*—

- 1956 *Antimelatoma canyonensis* Dell, Dominion Mus. Bull. no. 18, p. 142, fig. 196.

*Types*—Holotype and paratypes in the Dominion Museum, Wellington.

**Tholitoma dolorosa** Finlay & Marwick, 1937

(Pl. 235)

*Range*—New Zealand, Wangaloa (Wangaloan, Paleocene)

*Synonymy*—

1937 *Tholitoma dolorosa* Finlay & Marwick, N. Z. Geol. Surv. Pal. Bull. no. 15, p. 85, pl. 12, figs. 6, 7, 11.

1942 *Tholitoma dolorosa* Finlay & Marwick, Powell, Bull. no. 2, Auck. Inst. Mus., p. 65.

*Types*—The holotype is in the New Zealand Geological Survey.

**Genus Tholitoma** Finlay & Marwick, 1937

*Type*: *Tholitoma dolorosa* Finlay & Marwick, 1937

This is a monotypic genus, known only from the Paleocene of New Zealand. In size (14 mm.), general shape and in style of sculpture, it resembles *Eopleurotoma* Cossmann, 1889, but the sinus is turriculid, occupying the lower part of the flat excavated shoulder slope, but clear of the peripheral angle. Shell fusiform, with medially angulate whorls, the angle encircled by a strong nodulose rounded keel. There is also a strong subsutural nodulose spiral cord; between them the shoulder area is smooth. From below the periphery the whorls, including the base, are strongly spirally sculptured with closely spaced cords. Protoconch dome-shaped of 3½ smooth rapidly increasing strongly convex whorls.

*Synonymy*—

1937 *Tholitoma* Finlay & Marwick, New Zealand Geological Survey Palaeontological Bulletin, no. 15, p. 85: Type by original designation: *Tholitoma dolorosa* Finlay & Marwick, 1937.



Plate 235. *Tholitoma dolorosa* Finlay & Marwick. Paleocene of Wangaloa, New Zealand. 14.0 mm. (from Finlay & Marwick, 1937, pl. 12, fig. 11).



*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*

### Genus *Pleurofusua* Gregorio, 1890

**Type:** *Pleurotoma* (*Pleurofusua*) *longirostropis* Gregorio, 1890.

Unfortunately the type of Gregorio's genus seems to be known only from that author's original figure, which shows a small shell (17 mm.), with tall spire, an anterior canal of moderate length and strong *Fusinus*-like axial folds over-ridden by prominent spiral cords.

However, both Harris, 1937 (*Palaeontographica Americana*, vol. 2 (7), pp. 50-53) and Gardner, 1945 (*Geological Society of America, Mem.* 11, pp. 244-245), employ this genus for a series of S. E. American and Mexican species from the Claibornian and Jacksonian Eocene and the Vicksburgian Oligocene.

Following is a diagnosis of the genus from Gardner (1945):— "*Pleurofusua* includes a group of slender fusoid shells either small or of moderate dimensions. The nucleus is blunt and paucispiral, for the most part smooth, but with a few axial riblets on the final quarter turn. The conch is axially fluted, the swollen ribs tending to be opposite and protractive on the consecutive whorls. The spiral lirations are typically few in number, prominent, and equally vigorous on the axial and interaxial areas. The fasciole is concave, more or less undulated by the weakening

axials, and with no conspicuous spiral sculpture except the sutural cord. The growth lines are bent backward around the retral sinus in a broad shallow notch with the axis of the sinus slightly closer to the periphery than to the posterior suture. The aperture is narrow, the anterior canal rather short."

It should be noted that Gardner's use of the term "paucispiral" in the above context allows a nuclear whorl count of from 1½-2 whorls in *hilgardi* Casey, 1903 to just over 4 whorls in *servata* Conrad, 1847.

Vredenburg (1921, *Rec. Geol. Surv. India*, vol. 53 (2), pp. 90-96), assigned to *Pleurofusua*, a group of Burmese Kama Stage, Aquitanian Miocene fossils and there seems to be no reason to doubt this determination for these shells exhibit all the essential characteristics of *Pleurofusua*, namely, the bold fold-like axials, more or less in vertical series from whorl to whorl, crossed by crisp spirals, the concave shoulder area, smooth, except for a prominent subsutural spiral, and a not very dissimilar protoconch:—"consists of a *Calyptrea*-like nucleus followed by three tall, smooth, feebly convex whorls" (*phasma*).

Three Eocene species from Pakistan were assigned to *Pleurofusua* by Eames (1952, *Philos. Trans. Roy. Soc., London*, ser. B, vol. 236, pp. 131-132), but the nature of the material, which is undersized and fragmentary, leaves some doubt regarding their generic identity.

"The slight differences in type of ornament do not seem to warrant the separation of *Tropisurcula*, which has the same general form and type of protoconch." (Eames, 1952, p. 131)

### Key to species of *Pleurofusua*

- A. Axials diminished over shoulder slope
  - Subsutural margining plain
    - Periphery broadly rounded
      - Body-whorl rapidly contracted
        - Spire 24-25 ..... *phasma* (Vredenburg)
        - Spire 30 ..... *iravadica* (Vredenburg)
      - Body-whorl slowly contracted
        - Spire 34-38 ..... *feddeni* (Noetling)
    - Subsutural margining crenulated
      - Periphery carinated ..... *hanguensis* (Cox)
    - Subsutural margining obsolete
      - Periphery subcarinated
        - Spire 30-35 ..... *scala* (Vredenburg)
  - B. Axials undiminished over shoulder slope
    - Periphery rounded
      - Spire 35-36 ..... *fusus* (Vredenburg)

*Synonymy—*

- 1890 *Pleurofusua* Gregorio, Monographie de la Faune Eocenique de l' Alabama, Palermo, p. 34. Type by original designation: *Pleurotoma* (*Pleurofusua*) *longirostropis* Gregorio, 1890.
- 1904 *Tropisurcula* Casey, Trans. Acad. Sci. St. Louis, vol. 14 no. 5, p. 153: Type by subsequent designation, Cossmann, 1906; *Drillia caseyi* Aldrich, 1903.
- 1906 *Tropidosurcula* Cossmann, Essais de Paléoconchologie Comparée, vol. 7, p. 222. An emendation of *Tropisurcula* Casey, 1904.
- Characteristic species* (apart from those dealt

with in this number)—Southern United States, Eocene:—*claibarena* Harris, 1937, *collaris* (Casey, 1903), *fluctuosa* (Harris, 1937), *hilgardi* (Casey, 1903), *huppertzi* (Harris, 1895), *longirostropis* (Gregorio, 1890), *parahilgardina* (Palmer, 1947), *servata* (Conrad, 1847), *servatoidea* (Aldrich, 1895), *subservata* Palmer, 1947; Oligocene:—*vicksburgensis* (Casey, 1903). California, Eocene:—*clarki* (Dickerson, 1913), *fresnoensis* (Arnold, 1909).



? *Pleurofusua amphibola* (Cossmann & Pissarro, 1909)

(Pl. 236, figs. 2, 3)

*Range*—Lower beds, three miles east of old coal pit near Leilan, N. W. India, Ranikot Series, Eocene.

*Remarks*—Vredenburg (1928) relegated this species to the synonymy of the Parisian Basin Eocene *Pleurotoma polycesta* Bayan, 1873, but at the same time he advocated retention of Cossmann & Pissarro's name in a varietal sense for their figure "35", stating that the specimen has the ribs more numerous, more persistent anteriorly on the base, and the spiral sculpture is coarser.

Further discussion, without access to the relevant material, most of which is apparently in very poor condition, can serve no purpose, but in the interim the Indian material would seem to rest more happily under the designation of *amphibola*, rather than to align it with a species as remotely situated as the Paris Basin.

*Synonymy*—

- 1909 *Pleurotoma* (*Eopleurotoma*) *amphibola* Cossmann & Pissarro, *Palaeont. Indica* (n.s.), vol. 3, Mem. no. 1, p. 14, pl. 1, figs. 33-35.  
 1921 *Surcula* (*Pleurofusua*) *polycesta* (Bayan), Vredenburg, *Rec. Geol. Surv. India*, vol. 53, part 2, p. 87.  
 1928 *Surcula polycesta* (Bayan, 1873) and var. *amphibola* (C. & P., 1909), Vredenburg, *Palaeont. Indica* (n.s.), vol. 10, Mem. no. 4, p. 22.

*Pleurofusua hanguensis* (Cox, 1930)

(Pl. 236, figs. 1)

*Range*—Hangu Shales, Tertiary of the Samana Range, India.

*Remarks*—The author of this species considered it to be closely allied to *amphibola* (Cossmann & Pissarro, 1909), which, however is only half the size and has more numerous and finer spiral sculpture.

*Description*—Shell of medium size, 35 mm. (1<sup>3</sup>/<sub>8</sub> inches) in height, fusiform, with a tall spire, probably slightly taller than the height of the aperture plus canal. Protoconch small, conical. Post-embryonic whorls about 9, firstly with a heavy subsutural fold, prominently sculptured with cog-like nodes, followed by a rather narrow, slightly concave, steeply descending shoulder slope to a bluntly rounded peripheral angle, at, to a little above median whorl height. Sculpture of very broad rounded axial folds, 6-8 per whorl, overridden by prominent, sharply crested spiral

carinae, three to four on the spire-whorls, and with one or more crisp threads in each interspace.

*Measurements* (mm.)—

height	width
35.0	12.0

*Synonymy*—

- 1930 *Turricula* (*Pleurofusua*) *hanguensis* Cox, *Mem. Geol. Surv. India* (n.s.), vol. 15, p. 193, pl. 20, figs. 12a, b.

*Pleurofusua feddeni* (Noetling, 1895)

(Pl. 237, figs. 1, 2)

*Range*—Yenangyat, Burma, Sitsayan Stage, Stampian, Oligocene.

*Remarks*—This species is based upon an imperfect fossil with both the early whorls and the end of the canal missing. The main features of the species are the regular narrow spiral cords,

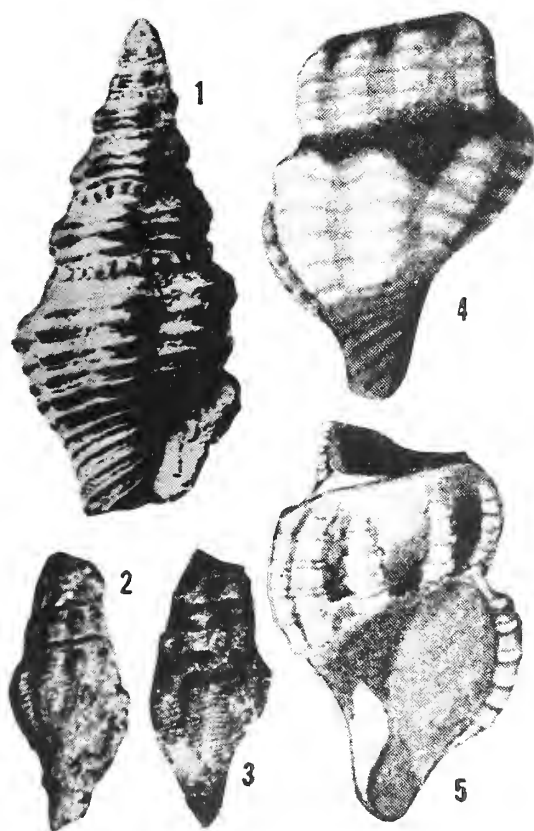


Plate 236. Fig. 1, *Pleurofusua hanguensis* (Cox). Hangu Shales, Tertiary of the Samana Range, India. 35 mm. (from Cox, 1930, pl. 20, fig. 12). Figs. 2, 3, *Pleurofusua amphibola* (Cossmann & Pissarro). India, Leilan, Post Eocene. 17 mm. (from Cossmann & Pissarro, 1909, pl. 1, figs. 33, 35). Figs. 4, 5, *Pleurofusua pseudoscala* Eames. Eocene of Pakistan. 1.9 mm. (from Eames, 1952, pl. 6, figs. 139a, b).

which override the prominent rather distant stout fold-like axials, and the long very gradually contracted body-whorl. Vredenburg (1921, l.c. p. 90), inferred that his *iravadica* and Noetling's *feddeni* were very similar, by admitting that imperfect fragments of the two were impossible to distinguish, but claimed that in adult *feddeni* the axials increase in prominence with growth whereas they do not alter, or more frequently decrease in prominence in *iravadica*. Regarding Noetling's subsequent figures ascribed to *feddeni* (1901, l.c.), figs. 23 and 23a seem to correctly represent the original *feddeni*, but fig. 24 does not, and has been renamed *scala* by Vredenburg, 1921. The present writer does not have access to any of the relevant material so further discussion here would serve no useful purpose.

#### Synonymy—

- 1895 *Fasciolaria feddeni* Noetling, Mem. Geol. Surv. India, vol. 27 no. 1, p. 35, pl. 8, fig. 4.  
 1895 *Pleurotoma (Drillia) interrupta* Lamarck, Noetling (non Lamarck, 1816), Mem. Geol. Surv. India, vol. 27 no. 1, p. 41, pl. 10, fig. 1 (non fig. 2 = *Drillia protointerrupta* Noetling, 1901).  
 1901 *Surcula feddeni* (Noetling), Palaeont. Indica, n.s., vol. 1, p. 346, pl. 22, figs. 22, 22a, 23, 23a (non 24, 24a = *Surcula (Pleurofusua) scala* Vredenburg, 1921).  
 1921 *Surcula (Pleurofusua) feddeni* (Noetling), Vredenburg, Rec. Geol. Surv. India, vol. 27 no. 1, p. 35, pl. 8, fig. 4.

#### *Pleurofusua iravadica* (Vredenburg, 1921)

(Pl. 238, figs. 1, 2)

**Remarks**—The author considered his species to be very closely allied to *feddeni* Noetling, 1895, and remarked that—"The leading difference between *Surcula feddeni* and *Surcula iravadica* is to be sought in the development of the ribs, which increase considerably in prominence with increasing growth in *Surcula feddeni*, while in *Surcula iravadica*, they either do not alter in character on the newer parts of the shell, or even, more frequently, distinctly decrease".

The species also resembles *phasma* Vredenburg, in sculptural detail but is proportionately wider with a spire angle of 30°, more rounded whorls and a narrower more concave shoulder area.

**Measurements**, not given, but the figure indicates a height of about 32 mm.

#### Synonymy—

- 1921 *Surcula (Pleurofusua) iravadica* Vredenburg, Rec. Geol. Surv. India, vol. 53 no. 2, p. 90, pl. 12, f. 9.  
**Records**—BURMA: Dalabe, Kyaungon, Myaukmigon, Thanga (Kama Stage, Aquitanian Miocene).

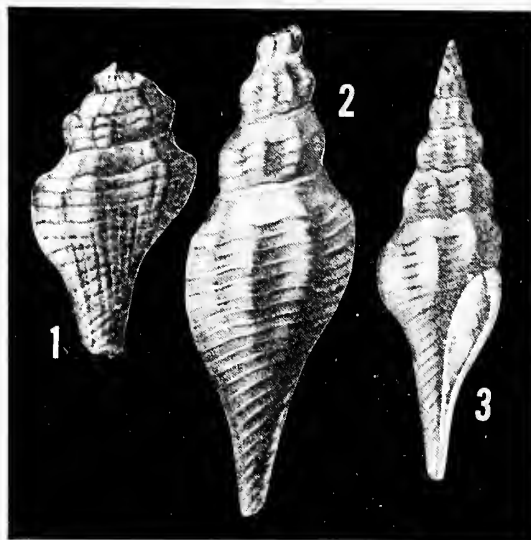


Plate 237. Fig. 1, *Pleurofusua feddeni* (Noetling). Oligocene of Yenangyat, Burma. 51.0 mm. (from Noetling, 1895, pl. 8, fig. 4). Fig. 2, *Pleurofusua feddeni* (Noetling) (from Noetling, 1901, pl. 22, fig. 23a). Fig. 3, *Pleurofusua scala* (Vredenburg). Miocene, Kama Stage of Burma (from Noetling, 1901, pl. 22, fig. 24; as *feddeni*, non Noetling, 1895).

#### *Pleurofusua phasma* (Vredenburg, 1921)

(Pl. 238, figs. 3, 4)

**Remarks**—This species is easily distinguished by its very slender proportions.

**Description**—Shell of medium size, 29-45 mm. (1-1¾ inches) in height, elongate-fusiform with tall narrow spire, 24-25°, and long straight anterior canal. Shoulder broad, steeply descending, slightly concave. Suture submargined by a prominent narrow sharply raised spiral cord. Whorls 8, plus a tall conoidal protoconch with a *Calyptraea*-like nucleus, followed by three tall smooth feebly convex whorls. Post-nuclear whorls bluntly angulate at about two thirds whorl height. Sculpture of broad axial folds, 5-7 per whorl, overridden by crisp spiral cords; about six spiral cords from the peripheral angle to the lower suture, numbers 1 and 3 from above, somewhat stronger than the rest. Spire equal to height of aperture plus canal. Sinus narrow and deep, on the shoulder slope.

#### Measurements (mm.)—

height	width	
45.0	11.0	
29.0	7.0	(holotype)

*Synonymy*—

1921 *Surcula* (*Pleurofusua*) *phasma* Vredenburg, Rec. Geol. Surv. India, vol. 53 no. 2, pl. 93, pl. 12, fig. 7.

1962 *Fusiturricula phasma* var. (Vredenburg), Dey. Pal. Indica (n.s.) vol. 36, p. 96, pl. 7, fig. 23.

*Types*—The holotype is in the Geological Survey of India, Calcutta.

*Records*—BURMA: Kyaungon, Myaukmigon, Thanga, Tittabwe (Kama Stage, Aquitanian Miocene). INDIA: Quilon, Kerala (Miocene).

**? *Pleurofusua fusus* (Vredenburg, 1921)**

(Pl. 238, fig. 6)

*Remarks*—This species was assigned to *Pleurofusua* by its author but the identification is doubtful for it is unlike the other Burmese fossils grouped with it, in that the axial folds extend from suture to suture, there being a complete absence of the characteristic concave sinus fasciole. This shell bears a striking resemblance to *Fusinus*, except that the growth lines indicate a deep sub-sutural sinus.

*Measurements* (mm.)—(estimated by Vredenburg from the several incomplete specimens)

height	width
55.0	19.0

*Synonymy*—

1921 *Surcula* (*Pleurofusua*) *fusus* Vredenburg, Rec. Geol. Surv. India, vol. 53 no. 2, p. 90, pl. 12, fig. 6.

*Records*—BURMA: Payagyigon, Letpanzeik (Chattian, Oligocene).

**? *Pleurofusua lakiensis* (Nath & Chiplonker, 1938)**

*Remarks*—This is known only from a worn fragment of the spire, which exhibits heavy axial sculpture. It was regarded by Eames (1952, l.c.) as possibly a *Pleurofusua*.

*Measurements* (mm.)—

height	width
—	17.0 mm.

*Synonymy*—

1938 *Turricula lakiensis* Nath & Chiplonker, Proc. Indian Acad. Sci. 6 (sect. B), p. 233, pl. 16, fig. i.

*Records*—WESTERN PAKISTAN, Laki dome, Sind (Ypresian Eocene).

**? *Pleurofusua obliquinodosa* (Eames, 1952)**

*Remarks*—This species is based upon a small fragment of four whorls, mostly internal cast, but with several small adherent areas of original shell, which reveal a sculpture of bold rounded protractively oblique axials, stopped above at a smooth shoulder concavity and crossed by four strong sharp spirals. The author compared his shell with the foregoing *Turricula lakiensis* Nath & Chiplonker.

*Measurements* (mm.)—

height	width
3.2 +	1.9

*Synonymy*—

1952 *Turricula* (*Pleurofusua*) *obliquinodosa* Eames, 1952, Philos. Trans. Roy. Soc. of London, ser. B, vol. 236, p. 131, pl. 6, fig. 138.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—PAKISTAN: (Rakhi Nala section, Upper Chocolate Clays, Eocene).

**? *Pleurofusua pseudoscala* (Eames, 1952)**

(Pl. 236, figs. 4, 5)

*Remarks*—This species is based upon a fragment composed of little more than the body-whorl, and with dimensions of only  $1.9 \times 1.3$  mm. Its author compared the shell with *Turricula* (*Pleurofusua*) *scala* Vredenburg, from the middle Miocene of Burma.

*Description*—(extract from original) "Ornament consisting of spiral threads and axial ribs. Four spiral threads, strong, sharp, about half the width of their intervals, and restricted to that portion of the whorls anterior to the concave band . . . Axial ribs strong, nodular, straight, vertical or slightly retrocurrent, of about the same width

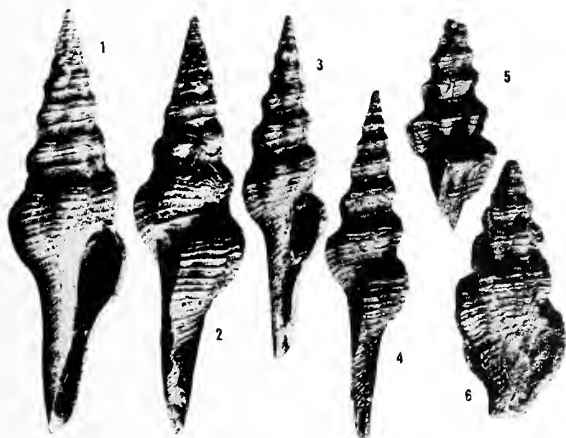


Plate 238. Figs. 1, 2, *Pleurofusua iravadica* (Vredenburg). Burma, Kama Stage of the Aquitanian Miocene. About 32 mm. Figs. 3, 4, *Pleurofusua phasma* (Vredenburg). Burma, Kama Stage of the Aquitanian Miocene. 29.0 mm. Fig. 5, *Pleurofusua scala* (Vredenburg). Burma, Kama Stage of the Aquitanian Miocene. About 32 mm. Fig. 6, *Pleurofusua fusus* (Vredenburg). Burma, Payagyigon, Letpanzeik of the Chattian Oligocene. 55 mm. (all from Vredenburg, 1921, pl. 12, figs. 6-9).



as their intervals on the earlier whorls, becoming more widely spaced on later whorls where they are little more than half the width of their intervals; there are nine ribs on the last whorl of the holotype”.

*Measurements (mm.)—*

height	width
1.9	1.3

*Synonymy—*

1952 *Turricula (Pleurofusua) pseudoscala* Eames, Philos. Trans. Roy. Soc. of London, ser. B, vol. 236, p. 132, pl. 6, fig. 139a, b.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—PAKISTAN: (Rakhi Nala section, Upper Chocolate Clays, Eocene).

***Pleurofusua scala* (Vredenburg, 1921)**

(Pl. 237, fig. 3; pl. 238, fig. 5)

*Range*—Burma, Kama Stage, Aquitanian, Miocene.

*Remarks*—This name, unaccompanied by a description, was provided for one of Noetling's 1901 interpretations (fig. 24) of his *feddeni*. The main difference between *feddeni* and *scala* is in

the shape of the body-whorl, which is long and very slowly contracted in *feddeni* but deeply excavated in *scala*. A further complication is encountered with Vredenburg's subsequent (1921, pl. 12, fig. 8) figure attributed to *scala*, which shows a shell with a much more sharply carinated peripheral angle. Only examination of the original material together with subsequently collected specimens will achieve a reasonable evaluation of this complex.

*Measurements (mm.) (approximation from plate)—*

height	width
51.0	16.5

Myauktin (Vredenburg, 1921, pl. 12, fig. 10)

*Synonymy—*

1901 *Surcula feddeni* (Noetling), Pal. Indica, n.s., vol. 1 no. 3, pl. 22, fig. 24 (non figs. 22, 23 = *feddeni* Noetling, 1895).

1921 *Surcula (Pleurofusua) scala* Vredenburg, Rec. Geol. Surv. India, vol. 51, no. 3, p. 282.

?1921 *Surcula (Pleurofusua) scala* Vredenburg, Rec. Geol. Surv. India, vol. 53, no. 2, pl. 12, fig. 8 (Tittabwe) & fig. 10 (Myauktin).

*Records*—BURMA: Kama Stage, Aquitanian, Miocene (type locality); Tittabwe (Vredenburg, 1921, fig. 8); Myauktin (Vredenburg, 1921, fig. 10).

### Genus Makiyamaia MacNeil, 1960

**Type:** *Pleurotoma coreanica* Adams & Reeve, 1850

This genus resembles *Turricula*. However, the shell has a pagodiform spire, with a usually nodulose peripheral angulation. It has a somewhat truncated anterior end, a moderate, narrowly U-shaped sinus on the shoulder slope which is nearer to the periphery than to the suture. The paucispiral, smooth, subnaticoid protoconch is slightly wider than the first post-nuclear whorl. Like *Turricula*, the genus has an operculum with a medio-lateral nucleus on the columella side (Pl. 241, fig. 1). The genus occurs from the Miocene to the Recent of Japan, the Pliocene of Okinawa and today is living in the South China Sea, Korea and the Philippines.

#### Synonymy—

- 1952 *Makiyamaia*, list name only (*nomen nudum*) in Oyama, Japanese Assoc. Petroleum Technologists, Journ., vol. 17, no. 1, p. 62.  
 1955 *Makiyamaia*, (*nomen nudum*), in Kira, Coloured Illustrations of the Shells of Japan, p. 35, fig. 3.  
 1960 *Makiyamaia* (Kuroda ms.), MacNeil, Tertiary and Quaternary Gastropoda of Okinawa. U.S. Geol. Surv. Prof. Paper, no. 339, p. 106. Type by original designation: *Pleurotoma coreanica* Adams & Reeve, 1850.

### Makiyamaia coreanica (Adams & Reeve, 1850)

(Pl. 239, figs. 1, 2)

**Range**—Korea and Japan, 100 to 197 fathoms.

**Remarks**—The shell figured by von Martens, 1903, (Gast. deutschen Tiefsee-Exped., pl. 2, fig. 3) as *Surcula coreanica* (Adams & Reeve) is not that species, and was renamed *Surcula suratensis* by Thiele, 1925 (Deutschen Tiefsee-Exped. "Valdivia", vol. 17, pt. 2, p. 214). This species, which came from Surat Passage, Sumatra in 1280 metres, is not even a *Makiyamaia*, for both the style of protoconch and the sinus are discordant with that genus. Thiele's *suratensis* seems better placed, provisionally, in the genus *Comitas* (*sensu lato*).

**Description**—Shell of medium size, 28-34 mm. ( $1\frac{1}{8}$ - $1\frac{1}{38}$  inches) in height, fusiform-biconic, with pagodiform spire, a little taller than the height of the aperture plus canal, and base rapidly contracted to a moderately long, slightly flexed, unnotched anterior canal. Whorls  $8\frac{1}{2}$ , including a paucispiral smooth sub-naticoid protoconch of  $1\frac{1}{2}$  whorls. Post nuclear whorls strongly angulate just above the suture, which is unmarginated. Axial sculpture of strong rounded nodules, laterally compressed, barely encroaching on the shoulder area and not reaching the suture below; 16-18 nodules per whorl. Shoulder area wide, slightly concave and steeply descending. Surface smooth except for faint traces of fine spiral lirations, and numerous but irregular axial growth lines. Sinus of moderate depth, rather narrowly U-shaped, its apex below the middle of the shoulder slope. Colour either white with a thin pale yellowish periostracum, or typically, with the addition of reddish brown bands or zones,

### Key to species of Makiyamaia

- A. Peripheral carina just above the suture
  - Carina broadly rounded
    - Axials obsolete . . . . . *subdeclivis* (Yokoyama)
    - Axials 16-18 per whorl
      - Spire angle  $38^\circ$ 
        - . . . . . *coreanica coreanica* (Adams & Reeve)
        - Spire angle  $32^\circ$  . . . . . *coreanica okinawensis* MacNeil
  - Carina narrowly rounded
    - Spire angle  $32^\circ$  . . . . . *kurodae* Shuto & Ueda
    - Spire angle  $38^\circ$  . . . . . *acuticarinata* (Shuto)
- B. Peripheral carina about midway between sutures
  - Axials strong, about 12 per whorl
    - . . . . . *aritaensis* Shuto & Ueda



Plate 239. Figs. 1, 2, *Makiyamaia coreanica* (Adams & Reeve). Dredged Sagami Bay, Japan. 34.0 mm. Fig. 3, *Makiyamaia subdeclivis* (Yokoyama). Suruga Gulf, 57 fathoms, Japan. 27.0 mm. Fig. 4, *Makiyamaia coreanica okinavensis* MacNeil. Okinawa, Shinzato tuff, Miocene or Pliocene. 31.0 mm. (from MacNeil, 1960, pl. 14, fig. 22). Fig. 5, *Makiyamaia subdeclivis acuticarinata* (Shuto). Japan, south of Kakoi, Upper Middle Miocene. 18.3 mm. (from Shuto, 1961, pl. 9, fig. 7). Fig. 6, *Makiyamaia kurodae* Shuto & Ueda. Japan, Obo, Saga Prefecture, Upper to Middle Oligocene. 23.7 mm. (from Shuto & Ueda, 1963, pl. 6, fig. 10). Figs. 7, 8, *Makiyamaia aritaensis* Shuto & Ueda. Japan, Obo, Saga Prefecture, Upper Eocene to Middle Oligocene. 18.5 and 22.6 mm. (from Shuto & Ueda, 1963, pl. 1, figs. 7, 8).

one occupying the shoulder area and the other the upper part of the base. Operculum ovate, clavatulid, with a medio-lateral nucleus on the columellar side.

*Measurements (mm.)—*

height	width	
34.5	12.7	Japan, Sagami Bay
34.0	14.0	Japan, Sagami Bay
30.0	12.2	Japan, Tosa, 100 fathoms
28.0	11.5	Korea (holotype)

*Synonymy—*

- 1850 *Pleurotoma coreanica* Adams & Reeve, Zool. Voyage Samarang, Moll., p. 40, pl. 10, fig. 8.  
 1926 *Pleurotoma shimomatana* Yokoyama, Tokyo Imper. Univ. Faculty Sci. Journ. sect. 2, vol. 1, pt. 9, p. 330, pl. 38, figs. 6, 7.  
 1928 *Pleurotoma subdeclivis*, with forms *glabra*, *intermedia* and *tuberculata* Yokoyama (non Yokoyama, 1926), Tokyo Imper. Univ. Faculty Sci. Journ. sect. 2, vol. 3, pt. 7, p. 339.  
 1931 *Turricula shimomatana* (Yokoyama), Makiyama, Kyoto Imperial Univ. Coll. Sci., Mem. ser. B, vol. 7, no. 1, p. 46.  
 1934 *Turricula coreanica* (Adams & Reeve), Kuroda, Venus, vol. 4, no. 6, p. 386, figs. 15, 16.  
 1952 *Leucosyrinx coreanica* (Adams & Reeve), Kuroda & Habe, Recent Marine Mollusca of Japan, p. 62.  
 1955 *Makiyamaia coreanica* (Adams & Reeve), Kira, Coloured Illustrations of the Shells of Japan, pl. 35, fig. 3.  
 1960 *Makiyamaia coreanica* (Adams & Reeve), MacNeil, U.S. Geol. Surv. Prof. Paper no. 339, p. 107, pl. 5, figs. 16, 18, pl. 9, figs. 15, 19.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—KOREA (type locality). JAPAN: Kanagawa, Sagami Bay and Shizuoka (ANSP); off Tosa; off Hondo, 153 and 197 fathoms; Kii (USNM).

***Makiyamaia coreanica subspecies okinavensis* MacNeil, 1960**

(Pl. 239, fig. 4)

*Range*—Miocene-Pliocene of Okinawa, Ryukyu Islands.

*Remarks*—This subspecies is intermediate between typical *coreanica* and the species *subdeclivis*. It is slender and tall-spired as in *subdeclivis*, and like that subspecies has a surface sculpture of fine incised spiral lines, but the peripheral carina is strongly tuberculate instead of plain.

*Measurements (mm.)—*

height	width	
31.0	11.9	(holotype)

*Synonymy—*

- 1960 *Makiyamaia coreanica okinavensis* MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 108, pl. 14, fig. 22.

*Types*—The holotype is in the United States National Museum, Washington.

*Records*—OKINAWA: (Shinzato tuff member, Miocene or Pliocene).

***Makiyamaia aritaensis* Shuto & Ueda, 1963**

(Pl. 239, figs. 7, 8)

*Range*—Japan, upper Eocene to middle Oligocene.



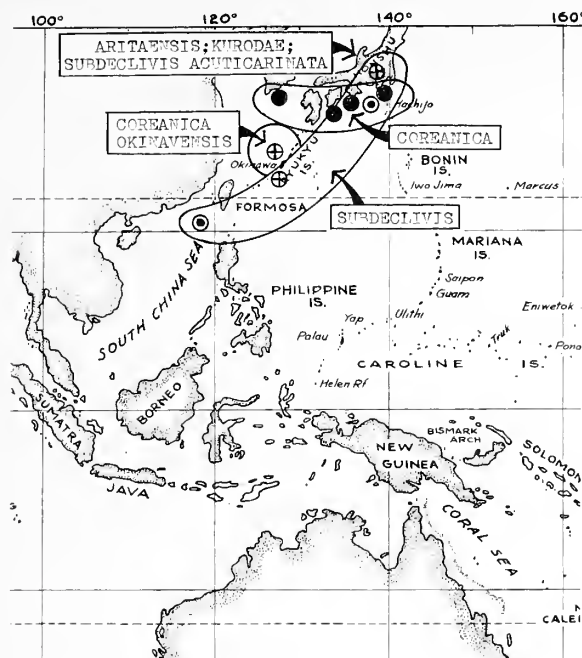


Plate 240. Geographical distribution of the Recent *Makiyamaia coreanica* (Adams & Reeve), *M. subdeclivis* (Yokoyama), and the Tertiary *M. aritaensis* Shuto & Ueda, *M. coreanica okinavensis* MacNeil, *M. kurodae* Shuto & Ueda and *M. subdeclivis acuticarinata* (Shuto).

**Remarks**—This species resembles the Recent *coreanica*, but is narrower, has a higher peripheral angle and the axial nodes are stronger and less numerous.

**Measurements (mm.)—**

height	width	
22.6	13.95	(holotype)
18.45	11.35	(paratype)

**Synonymy—**

1963 *Makiyamaia aritaensis* Shuto & Ueda, Jap. Journ. Geol. and Geogr., vol. 34, no. 1, p. 8, pl. 1, figs. 7, 8, 9, text fig. 1.

**Types**—The type material is in the Department of Geology, Kyushu University, Japan.

**Records**—JAPAN: Obo, Arita machi, Nishi-matsura gun, Saga Prefecture (type locality); Minami-takouchi, Nagayo mura, Nishi-sonogi gun, Nagasaki Prefecture (upper Eocene to middle Oligocene).

**Makiyamaia kurodae Shuto & Ueda, 1963**

(Pl. 239, fig. 6)

**Range**—Japan, upper Eocene to middle Oligocene.

**Remarks**—This species is claimed by its author to be close to *M. subdeclivis acuticarinata* Shuto, 1961, but is more slender, with the carina at a

slightly higher position in relation to the whorl height, which is proportionately greater than in *acuticarinata*.

**Measurements (mm.)—**

height	width	
23.7	15.1	(holotype)

**Synonymy—**

1963 *Makiyamaia kurodae* Shuto & Ueda, Jap. Journ. Geol. and Geogr., vol. 34, no. 1, p. 6, pl. 1, figs. 10, 14, text fig. 1.

**Types**—The type material is in the Department of Geology, Kyushu University, Japan.

**Records**—JAPAN: Obo, Arita machi, Nishi-matsura gun, Saga Prefecture (type locality); South-east of Matsuo, Nagayo mura, Nishi-sonogi gun; road side at Sonoda-hira, Toishi mura, Kita-takagi gun, Nagasaki Prefecture (upper Eocene to middle Oligocene).

**Makiyamaia subdeclivis (Yokoyama, 1926)**

(Pl. 239, fig. 3)

**Range**—Recent, Japan to South China Sea, 57–208 fathoms; Pliocene, Japan and Miocene, Okinawa.

**Remarks**—This species differs from *coreanica* in having a relatively taller and narrower spire, no tubercles on the periphery and a surface cover of fine incised spiral lines. Colour two banded in dark reddish-brown, one band occupying the whole of the shoulder slope, peripheral carina white, followed by the second band which occupies the upper base, neck and anterior canal yellowish-brown.

**Measurements (mm.)—**

height	width	
27.0	11.5	Japan, Suruga Gulf, 57 fathoms.
27.0	11.0	Japan (Pliocene) (holotype)
23.5	9.5	Japan, Suruga Gulf, 57 fathoms.

**Synonymy—**

1926 *Pleurotoma subdeclivis* Yokoyama, Tokyo Imper. Univ. Faculty Sci. Journ. sec. 2, vol. 1, pt. 9, p. 329, pl. 38, f. 8, p. 367, pl. 42, fig. 4.

1927 *Turricula subdeclivis* (Yokoyama), Makiyama, Kyoto Imper. Univ. Coll. Sci. Mem. ser. B, vol. 3, no. 1, p. 99.

1952 *Spirotropis subdeclivis* (Yokoyama), Kuroda & Habe, Recent Marine Mollusca of Japan, p. 87.

1960 *Makiyamaia coreanica subdeclivis* (Yokoyama), MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 107, pl. 5, fig. 20.

**Records**—JAPAN: Suruga Gulf, 57 fathoms (Albatross Sta. 5071; USNM.); CHINA SEA, off Pratas Island, 208 fathoms (Albatross Sta. 5301; USNM.).

**Fossil records**—JAPAN: Uchida and Kechienji formations (Pliocene) (type locality); OKINAWA (Yonabaru clay member, Miocene) (MacNeil, 1960).

***Makiyamaia subdeclivis subspecies  
acuticarinata* (Shuto, 1961)**

(Pl. 239, fig. 5)

*Range*—Japan, upper middle Miocene.

*Remarks*—This subspecies looks to be almost identical with *subdeclivis*. Shuto remarked that it differed from the species in being smaller, with a proportionately larger body-whorl, and in the more acute carina being so close to the lower suture, that the profile of the spire is rather flat-sided. These alleged differences, however, are slight, and will probably prove valueless when larger series become available. It is noted that there appears to be a greater range of variation among Shuto's figures, 8, 11 and 12, considered to be *subdeclivis*, than there is between figure 8 of that series, and figure 7, which is the holotype of *acuticarinata*.

*Measurements* (mm.)—

height	width	
18.3	8.4	(holotype)

*Synonymy*—

1961 *Spirotropis subdeclivis acuticarinata* Shuto, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol., vol. 11, no. 2, p. 103, pl. 9, fig. 7, text fig. 8.

*Types*—The type material is in the Department of Geology, Kyushu University, Japan.

*Records*—JAPAN: Brook side cliff, south of Kakoi, Sanzai mura, Koyu gun, Miyazaki Prefecture (Kawabaru member, upper middle Miocene).

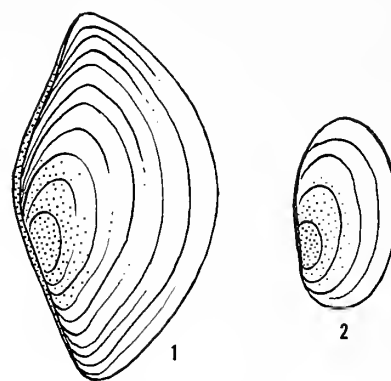


Plate 241. Opercula. Fig. 1, *Makiyamaia coreanica* (Adams & Reeve). Sagami Bay, Japan. Fig. 2, *Paradrillia patruelis* (E. A. Smith). 57 fathoms, off Honshu, Japan (from paratype).

### Genus *Paradrillia* Makiyama, 1940

Type: *Drillia dainichiensis* Yokoyama, 1923

A group of *Clavus*-like species characterized by a tall slender spire and a truncated anterior end, but with a turriculid style of posterior sinus and a clavatulid operculum (Pl. 241, fig. 2).

The protoconch of *Paradrillia* is small, polished and erect, of about 1½ smooth whorls, carinate or subcarinate towards its close, followed by a quarter whorl of brephic axials; the operculum is ovate, with a medio-lateral nucleus along its inner edge. A paratype of *patruelis* (Smith) in the British Museum (Natural History) has the operculum intact.

Both Makiyama (1940) and MacNeil (1960), who proposed the synonymous *Alticlavatula*, respectively made their propositions as subgenera of *Clavatula*, but the relationship is clearly with the turriculids.

The genus occurs Recent from the Persian Gulf to Japan and is found fossil in the Miocene of Java and the Pliocene of Formosa, Okinawa and Japan.

#### Synonymy—

1940 *Paradrillia* Makiyama (subgenus of *Clavatula*). Nomenclatural notes on some genera of Turridae. Trans. Palaeont. Soc. Japan in J. Geol. Soc. Japan, vol. 47, no. 558, pp. 133, 134. Type by original designation: *Drillia dainichiensis* Yokoyama, 1923.

1960 *Alticlavatula* MacNeil (subgenus of *Clavatula*). Tertiary and Quaternary Gastropoda of Okinawa. U.S. Geol. Survey Professional Paper, no. 339, p. 109. Type by original designation: *Pleurotoma patruelis* Smith, 1875.

#### Key to species of *Paradrillia*<sup>1</sup>

- A. Subsutural fold unicingulate, smooth or crenulated
  - Axials single peripheral row large pointed tubercles
    - Base strongly subangled . . . . . *astutoida* (Shuto)
    - Base weakly subangled . . . . . *minoensis* (Shuto)
    - Base not subangled . . . . . *lithoria* (Melvill & Standen)
  - Axials single peripheral row large blunt tubercles
    - Tubercles rounded
      - . . . . . *inconstans inconstans* (E. A. Smith)
    - Tubercles longer than wide
      - . . . . . *inconstans prunulum* (Melvill & Standen)
  - Axials double peripheral row vertically fused nodes
    - Subsidiary spirals fenestrated by axial threads
      - . . . . . *patruelis* (E. A. Smith)
    - Subsidiary spirals gemmulated by axial threads
      - . . . . . *dainichiensis* (Yokoyama)
  - Axials long, flexuous, thickened over peripheral area
    - Basal sculpture fenestrate, not gemmate
      - Axials lamellate, slightly thickened at periphery
        - . . . . . *alluaudi* (Dautzenberg)
      - Axials lamellate, greatly thickened at periphery
        - . . . . . *agalma* (E. A. Smith)
      - Axials cog-like on narrowly rounded periphery
        - . . . . . *melvilli* Powell, n. sp.
- B. Subsutural fold like spirally twisted rope
  - Basal spirals overriding long axials
    - . . . . . *celebensis* (Schepman)
- C. Subsutural fold bicingulate, gemmulate
  - Peripheral keel double row of strong gemmules
    - Subsidiary spirals finely gemmate
      - . . . . . *djocdjocartae* (K. Martin)

<sup>1</sup>The above key covers only the more readily diagnosed species; some have subtle combinations of characters difficult to express in key form, others are doubtfully distinct.



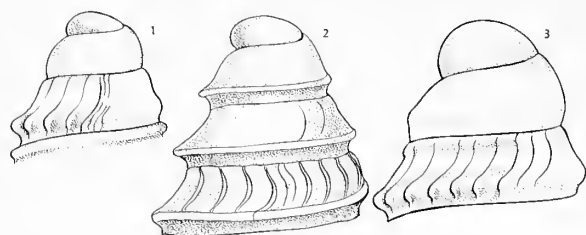


Plate 242. Protoconchs. Fig. 1, *Paradrillia inconstans prunulum* (Melvill & Standen). Muscat. Fig. 2, *Paradrillia melvilli* Powell, new species. Persian Gulf (holotype). Fig. 3, *Vexitomina metcalfei* (Angas). Sydney Harbour.

### *Paradrillia inconstans* (E. A. Smith, 1875)

(Pl. 243, figs. 5, 6)

*Range*—Japan in from 8 to 30 fathoms.

*Remarks*—The type specimens of this species are in the British Museum and they came from Oshima, Japan. Melvill (1917, p. 153, pl. 10, fig. 1), recorded the species from a number of localities in the Persian-Gulf-Arabian Sea area, but the figure he provided is obviously not of the Japanese type, but probably of one of his Persian Gulf specimens, and appears to be identical with Melvill and Standen's *prunulum*.

Also, Melvill's fig. 2, purported to represent *Pleurotoma pyramidula* Reeve, 1845, is evidently not that species either (see *Paradrillia melvilli* n. sp., described following). Unfortunately the type of Reeve's *pyramidula*, which should be in the British Museum, cannot be found. Reeve's figure shows a shell, more slender, longer in the body-whorl and with different sculptural detail than Melvill's interpretation. If the type of *pyramidula* is ever found, it is likely to prove

related to *Crassispira*, in the *Clavinae*, rather than to *Paradrillia*.

*Paradrillia inconstans* belongs to the same group as that centred around *patruelis* (Smith), from which it is distinguished mainly, by being more slender, in having a more prominent subsutural fold, and stronger peripheral nodes, not two vertically fused series as in *patruelis*.

*Description*—Shell small, 13 mm. ( $\frac{1}{2}$  inch) in height, claviform, with tall spire, about twice height of aperture plus canal, and truncated anterior end. Whorls 8+, protoconch and early whorls missing. Spire-whorls sculptured with a smooth, heavy subsutural fold, followed by a moderately wide and deeply concave shoulder area, bearing 2-3 irregularly finely beaded spiral threads; then the peripheral angle, set above middle whorl height, and bearing simple strong rounded nodes. Three to four unequal gemmate spiral cords between the periphery and the lower suture. A further 6-7 gemmate cords on the base to the anterior fasciole, which is indistinctly closely spirally lirate. Colour greyish-buff.

#### *Measurements* (mm.)—

height	width	
13.0	4.0	(one of three co-types)
4.8	2.7	(holotype of <i>asamusiensis</i> )

#### *Synonymy*—

- 1875 *Pleurotoma inconstans* Smith, Ann. Mag. Nat. Hist., ser. 4, 15, p. 417.  
 1940 *Clavatula asamusiensis* Nomura & Zinbo, Saito Ho-on Kai Mus. Res. Bull., no. 19, p. 18, pl. 2, fig. 12a, 12b.  
 1961 *Paradrillia inconstans* (Smith), Habe, Coloured Illustr. of the Shells of Japan, 2, pl. 38, fig. 4.  
 1969 *Paradrillia inconstans* (E. A. Smith), Shuto, Mem. Fac. Sci. Kyushu Univ., series D, Geology, vol. 19, no. 1, p. 194, pl. 20, figs. 9, 10, 14.

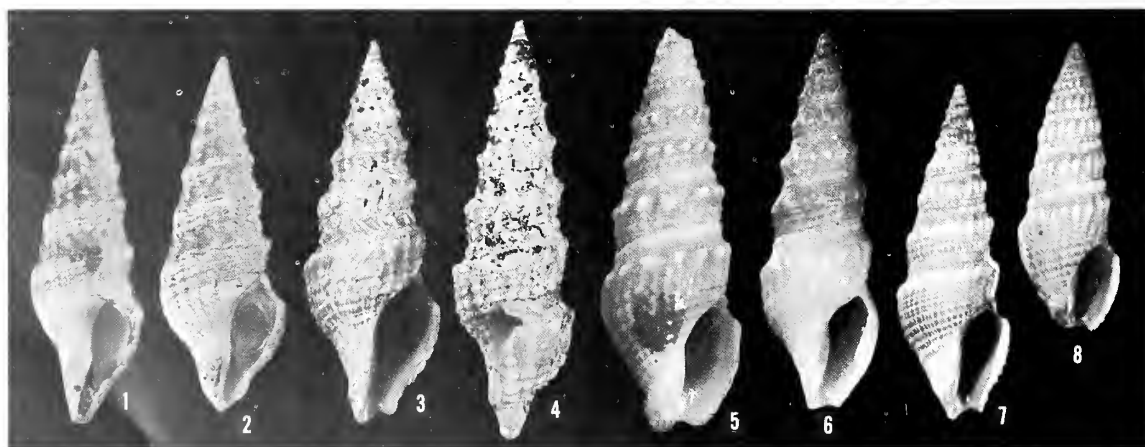


Plate 243. Figs. 1-4, *Paradrillia patruelis* (E. A. Smith). Fig. 1, 11 fathoms, Japan; holotype. 26.0 mm. Fig. 2, paratype. 26.5 mm. Figs. 3, 4, off Honshu, 57 fathoms, Japan. 26 and 27 mm. Figs. 5, 6, *Paradrillia inconstans* (E. A. Smith).

Ooshima Harbour, 8 fathoms, Japan; holotype. 13 and 12 mm. Figs. 7, 8, *Paradrillia inconstans prunulum* (Melvill & Standen). Muscat and Fort Reef, Karachi, respectively. 13.7 and 11.5 mm., respectively.

**Types**—There are three co-types of *inconstans* in the British Museum (Natural History).

**Records**—JAPAN: Oshima Harbour, 8 fathoms (type locality of *inconstans*); off Moura-zima, Asamusi-ken, 30 fathoms (type locality of *asamusiensis*). PHILIPPINES: Santa Barbara Silt, Panay Id. Neogene (Shuto, 1969, p. 194)

***Paradrillia inconstans subspecies prunulum* (Melvill & Standen, 1901)**

(Pl. 243, figs. 7, 8)

**Range**—Persian Gulf, Arabian Sea, India, Ceylon, Andaman Islands and Queensland.

**Remarks**—In a series of over sixty specimens from Persian Gulf and Arabian Sea localities, the original material examined by Melvill (1917), a great deal of variation is encountered, and it ranges from a small heavily sculptured shell, often with strong oblique axials on the subsutural fold, to a larger, more delicately sculptured shell, in which the subsutural fold is plain except for a weak medial carination. The former is what Melvill (1917, pl. 10, fig. 1) figured as *inconstans* Smith (non Smith, 1875), and the latter is *prunulum* (Melvill & Standen, 1901). It is impossible to draw a line between these two extremes, for they are bridged by varying combinations, some heavily sculptured but with a plain subsutural fold, some with the basal spirals dominant, and others with the axial folds dominating the basal spirals. True *inconstans* appears to differ from all the above combinations in that the peripheral nodes are more rounded, whereas in *inconstans prunulum* all specimens examined have the peripheral axials much longer than wide. Until more topotypic material of the Japanese *inconstans* is available, and its range determined, it is better to treat *prunulum* as a regional subspecies.

Preston's *Clavatulula gaylordae* from Ceylon, a shell of only 6 mm. in height, undoubtedly falls within the range of variation admissible for *prunulum*. This was suggested by the figure and confirmed by a co-type in the British Museum.

**Description**—Shell small, 9.5-15.0 mm. ( $\frac{3}{8}$ - $\frac{5}{8}$  inch) in height, claviform, with tall spire, almost twice height of aperture plus canal, and a truncated anterior end. Whorls 11, including a small smooth protoconch of  $2\frac{1}{2}$  whorls, first  $1\frac{1}{2}$  whorls dome-shaped, last whorl tall, rather straight-sided but with a submedian smooth carina, terminated by a strongly protractive axial thread and followed by a half-whorl of crisp brephic axials, accompanied by an increase in the strength of the submedian carina (Pl. 242, fig.

1). Spire-whorls with a strong medially carinate but otherwise smooth subsutural fold, followed by a rather narrow, deeply concave shoulder area, bearing two fine spiral threads. Then a medially placed prominent, rounded peripheral fold, sculptured with strong, slightly oblique smooth axials, which are much longer than they are wide; three spiral threads in their interspaces. Below this are two rather strong flat-topped spiral cords which are delicately beaded by numerous axial threads. On the body-whorl, from below the periphery, there are about nine flat-topped spirals, all delicately beaded by the numerous crisp axial threads. A concavity bearing two spiral threads separates the base from the anterior fasciole, which bears five rather strong linear-spaced spiral cords. Sinus deep, occupying most of the shoulder slope, its apex broadly rounded. Outer lip thin; anterior canal very short, obliquely broadly shallowly notched. Colour pale greyish to yellowish brown, with the peripheral fold and the anterior fasciole picked out in white (based upon a topotype; note the variations mentioned above, under "Remarks").

**Measurements (mm.)—**

height	width	
15.0	5.0	Muscat
13.75	4.8	Muscat
12.0	4.0	holotype
9.5	3.5	Henjam

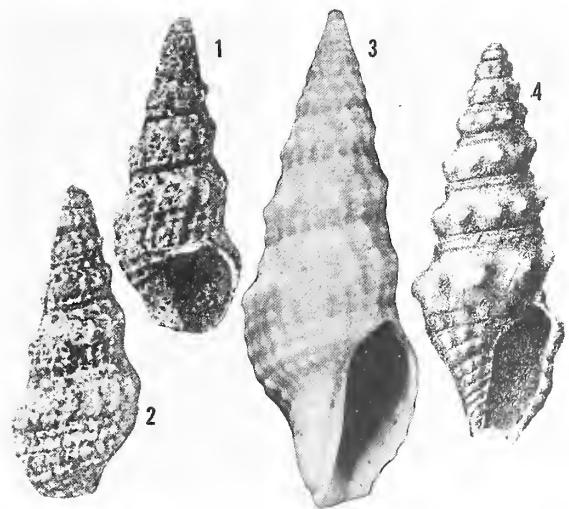


Plate 244. Figs. 1, 2, *Paradrillia dainichiensis* (Yokoyama). Dainichi Pliocene of Totomi, Japan (from Yokoyama, 1923, pl. 1, fig. 2). Fig. 3, *Paradrillia dainichiensis* (Yokoyama). Recent, Sagami Bay, Japan. 18.5 mm. Fig. 4, *Paradrillia lithoria* (Melvill & Standen). Persian Gulf, 6 fathoms. 8.0 mm. (from Melvill & Standen, 1903, pl. 22, fig. 20).

*Synonymy*—

- 1901 *Drillia prunulum* Melvill & Standen, Proc. Zool. Soc., p. 439, pl. 24, fig. 2.  
 1905 *Clavatula gaylordae* Preston, Journ. of Malac., vol. 12, p. 2, pl. 1, fig. 2.  
 1917 *Drillia inconstans* Smith (not of Smith, 1875), Melvill, Proc. Malac. Soc., vol. 12, pl. 10, fig. 1.

*Types*—The holotype of *prunulum* and a co-type of *gaylordae* are in the British Museum (Natural History).

*Records*—PERSIAN GULF and ARABIAN SEA: Henjam Island, 14 fathoms; Shaikh Shuaib Island and Pasni, 40 fathoms; Gulf of Oman, 37 fathoms; Angrias Bank and Malabar Coast, 5 fathoms; Kuwait, 10 fathoms (Townsend and Winckworth collections, Brit. Mus.). INDIA: Fort Reef, Karachi (Townsend coll., Brit. Mus.). CEYLON (type locality of *gaylordae*). ANDAMAN ISLANDS, Port Blair (Winckworth coll., Brit. Mus.). QUEENSLAND: Darnley Island, 30 fathoms (Aust. Mus.); Buchan's Point; Gladstone Harbour (Mrs. J. Kerslake).

*Paradrillia lithoria* (Melvill & Standen, 1903)

(Pl. 244, fig. 4)

*Range*—Persian Gulf, Bahrein Islands, 6 fathoms, coral-sand.

*Remarks*—This species belongs to the *inconstans* group, and is characterised by the relatively few, but strong rounded peripheral nodules, and again in the paucity of the basal spirals, which nevertheless are quite strongly nodulose.

*Description*—Shell small, solid, 8 mm. ( $\frac{5}{16}$  inch) in height, claviform, with tall spire and truncated anterior end. Whorls 8, including a small broadly rounded smooth protoconch of 2 whorls. Subsutural fold prominent, medially carinate. Whorls medially sculptured with strong bluntly rounded knob-like axials set on a blunt angulation. These knobs appear to be between 7-8 per whorl. Spiral sculpture is represented by about five strong nodulose cords on the base, followed by about five weaker smooth spiral cords on the anterior end. Colour pale reddish brown.

*Measurements (mm.)*—

height	width
8.0	2.5

*Synonymy*—

- 1903 *Drillia lithoria* Melvill & Standen, Ann. Mag. Nat. Hist., ser. 7, vol. 12, p. 313, pl. 22, fig. 20.  
 1917 *Drillia lithoria* Melvill & Standen, Melvill, Proc. Malac. Soc., vol. 12, p. 157.

*Types and Records*—The holotype is in the British Museum (Natural History). It is known only from the type locality: 6 fathoms, off Bahrein Islands, Persian Gulf.

*Paradrillia melvilli* new species Powell

(Pl. 245, figs. 1, 2)

*Range*—Persian Gulf to northwest India.

*Remarks*—This is the species erroneously claimed by Melvill (1917, Proc. Malac. Soc., 12, p. 153, pl. 10, fig. 2) to be *Pleurotoma pyramidula* Reeve, 1845, described without locality. Melvill did not state the basis of his fig. 2, but it is obviously a Persian Gulf shell, not Reeve's type, which has not been located in the British Museum collection. Melvill's shell is undoubtedly a *Paradrillia*, closely allied to *inconstans prunulum* (Melvill & Standen, 1901).

Reeve's figure of his *pyramidula* shows a very different shell which appears to be clavineid, as evidenced by a prominent parietal callus-pad. Other features exhibited by Reeve's figure that are discordant with Melvill's interpretation are the inwardly reflected outer lip, which shows a crenulated inner edge, and the closely spaced rounded long axials, crossed by incised lines; on the spire-whorls these lines cut the axials into four series of nodulose spirals, including the peripheral row. These observations on Reeve's illustration are in part, however, at variance with his description, especially the passage "very closely latticed with minute longitudinal and transverse ridges".

Since Reeve's type cannot be found, the locality is unknown, and the figure does not match the description, the only course is to describe and re-name Melvill's *pyramidula*.

The new species *melvilli* differs from *inconstans prunulum* in being of lighter build, with finer, more openly clathrate sculpture and a distinctive protoconch, which has the second and third whorls sharply carinate.

*Description*—Shell small, of light build, 7-8 mm. ( $\frac{5}{16}$  inch) in height, claviform, with tall spire, almost twice height of aperture plus canal, and a short anterior canal which is widely open, with an oblique, broad, but moderately deep notch. Whorls 9, including an erect conical protoconch, the tip smooth and papillate, followed by two whorls, which are strongly carinated towards the lower suture (Pl. 242, fig. 2). This is followed by another strongly carinate whorl which bears concavely arcuate brephic axials. Remaining spire whorls with a rather strong rounded subnodose subsutural fold, followed by a moderate shoulder concavity, which bears regular concavely arcuate axial growth lines, but no spirals.



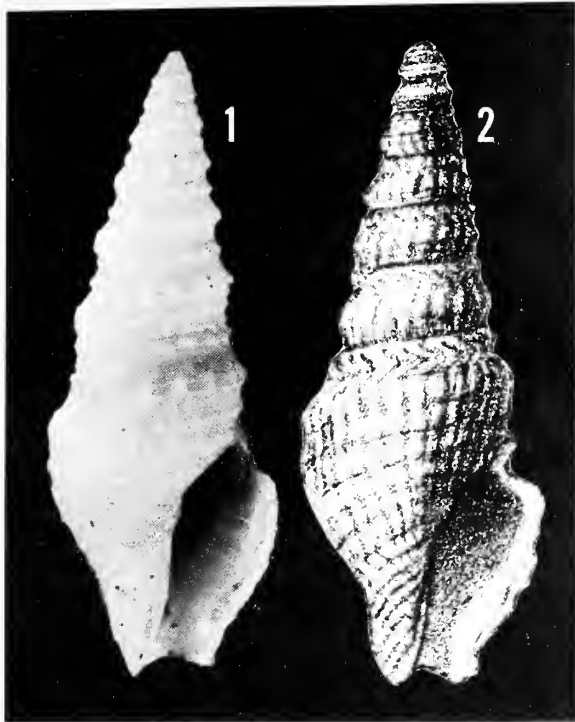


Plate 245. Fig. 1, *Paradrillia melvilli* Powell, new species. Persian Gulf, holotype. 8.0 mm. Fig. 2, *Paradrillia melvilli* Powell, new species. 8.0 mm. (from Melvill, 1917, pl. 10, fig. 2, as *Drillia pyramidula* (Reeve), non Reeve, 1845).

There is a medially situated blunt peripheral keel which bears rather weak cog-like axial nodes, 18 or 19 per whorl. Below this there is a thread, mid-way between the periphery and the lower suture, and a second thread is emergent suturally on the penultimate and body-whorls. Body-whorl with six narrow spiral threads and five rather stronger and more closely spaced spirals over the anterior end. Weak lamellate threads follow down from the arcuate axials of the shoulder slope, through the peripheral nodes and reticulate with the spiral threads below; becoming very weakly gemmulate at the points of intersection. Outer lip thin with a deep U-shaped sinus, the rounded apex of which occupies most of the shoulder slope. Inner-lip lightly glazed, without a parietal callus-pad or tubercle. Colour pure white.

*Measurements (mm.)—*

height	width	
8.0	3.0	holotype
8.0	2.9	Kuh i Mubarik, 45 fathoms

*Synonymy—*

1917 *Drillia pyramidula* (Reeve), Melvill, Proc. Malac. Soc., vol. 12, pl. 10, fig. 2 (not of Reeve, 1845).

*Types*—The holotype from the Sykes' collection is in the British Museum (Natural History).

*Records*—PERSIAN GULF: (type locality); Kuwait, 10 fathoms; Henjam Island; GULF OF OMAN, 156 fathoms; Muscat, 10 fathoms; Kuh-i-Mubarik, 45 fathoms. MEKRAN COAST, Charbar, 40 fathoms. PAKISTAN: Karachi (British Mus., Nat. Hist.).

*Paradrillia patruelis* (E. A. Smith, 1875)

(Pl. 243, figs. 1-4)

*Range*—Japan to Philippines, shallow water to 182 fathoms.

*Remarks*—Refer to the remarks under *Paradrillia dainichiensis* (Yokoyama) for the reasons for considering *consimilis* Smith, 1879 a synonym of *patruelis* Smith, 1875.

*Description*—Shell small, 22-27 mm. (ca 1 inch) in height, with a tall narrow spire, 25°-28°, and a truncated anterior end. Spire  $1\frac{2}{3}$  height of aperture plus canal. Whorls  $10\frac{1}{2}$  to 11, including a small smooth erect dome-shaped protoconch of  $1\frac{1}{2}$  whorls, followed by a quarter whorl of stout brephic axials. Spire whorls with firstly a conspicuous rounded subsutural fold, followed by a wide steeply descending concave shoulder area to a centrally placed bluntly rounded and projecting peripheral keel, the whole encircled by spiral lines and cords, crossed by much stronger rounded and flexuous axials which are continuous from the lower suture to the peripheral carina, tend to become obsolescent over the shoulder area but regain strength as a series of bluntly rounded bosses, studding the subsutural fold. Three or four spiral threads on the shoulder slope, 2-3 fused to form the peripheral carina and four cords between the carina and the lower suture, the lower pair the stronger. Base with a further four strong spiral cords, each rendered nodulose where crossed by the axials, which number 16-17 per whorl, followed by 6 plain spirals on the anterior end. Aperture subquadrate, narrower than high, with an excavated smooth parietal area but no callus pad or tubercle. Outer lip thin and unvariced. Anterior canal very short with an oblique shallowly notched termination. Anal sinus moderately deep, with a broadly rounded apex, situated at the middle of the shoulder slope. Below, the sinus is confluent with the forwardly projected arcuate slope of the outer lip. Colour pale reddish-brown except for two white spiral bands, one at the peripheral carina and the other on the base just below the level of the top of the aperture.

*Measurements (mm.)—*

height	width	
27.0	8.5	Japan, Honshu, 57 fathoms
26.5	9.5	Japan (paratype of <i>patruelis</i> )
26.0	8.0	Japan (holotype of <i>patruelis</i> )
26.0	9.0	Japan, Honshu, 57 fathoms
21.0	7.5	Japan, Nagasaki

*Synonymy—*

- 1875 *Pleurotoma patruelis* E. A. Smith, Ann. Mag. Nat. Hist., ser. 4, vol. 15, p. 419.  
 1879 *Pleurotoma patruelis* E. A. Smith, Proc. Zool. Soc., London, p. 188, pl. 19, fig. 10.  
 1879 *Pleurotoma consimilis* E. A. Smith, Proc. Zool. Soc., London, p. 188, pl. 19, fig. 11 (non *Pl. consimilis* Risso, 1826).  
 1960 *Clavatula (Alticlavatula) patruelis* (Smith), MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 109.  
 1961 *Paradrillia patruelis* (Smith), Habe, Coloured Illust. Shells of Japan, vol. 2, pl. 38, fig. 7.

*Types*—Holotype and paratype of *patruelis*, and holotype of *consimilis* in the British Museum (Natural History).

*Records*—JAPAN: 34° 6'N., 136° 15'E., 11 fathoms (type locality of *patruelis*); off Honshu Island, 57 fathoms; Nagasaki (USNM); south of Korea, 24 fathoms (type locality of *consimilis*). PHILIPPINES: off Capitancillo Island, North Cebu, 182 fathoms, green mud (Albatross Sta. 5403, USNM).

*Paradrillia dainichiensis* (Yokoyama, 1923)

(Pl. 244, fig. 1-3)

*Range*—Japan, Pliocene and Recent.

*Remarks*—When Yokoyama described this species from a Japanese Pliocene locality he also provided a name for the Recent shell, which Japanese authors have identified as either *Pleurotoma consimilis* E. A. Smith, 1879 (pre-occupied by Risso, 1826) or “*Clavatula dainichiensis viva* Makiyama”, apparently a manuscript name, first quoted by Kuroda & Habe, 1952, “Check List and Bibliography of the Recent Marine Mollusca of Japan”, p. 47. Actually, the holotype of *consimilis*, which is in the British Museum, reveals a shell well within the range of variation admissible for *patruelis* E. A. Smith, 1875; in fact, the paratype of *patruelis* is indistinguishable from the holotype of *consimilis*. Mrs. Virginia Maes, to whom I referred the problem of “*viva* Makiyama” is of the opinion that references to this name probably all stem from Kuroda’s manuscript check list of Japanese Recent Mollusca.

A figure is provided of the Japanese shell usually misidentified as *consimilis*, and this proves to be inseparable from the Pliocene *dainichiensis*, thus making “*viva* Makiyama” redundant.

The species *dainichiensis* differs from *patruelis*

mainly in having stronger spiral cords, which are rendered noticeably gemmulate at the points of intersection with the closely spaced axials. The axials on both the subsutural fold and the peripheral carina are formed of vertically fused nodes, which traverse two or more spirals. The relative strengths of these subsutural and peripheral axials vary considerably in both the Pliocene and the Recent populations.

The following list names in Otuka, 1930 (Journ. Geol. Soc., Tokyo, vol. 37, No. 441, p. 275) were cited as Neogene forms of *Clavatula* (i.e. *Paradrillia*) by Nomura, 1935, Catalogue of the Tertiary and Quarternary Mollusca from the Island of Taiwan (Formosa), who remarked that the species and subspecies in question have been neither figured nor described. These *nomina nuda* of Otuka, 1930 are:—*Clavatula dainichiensis muraokensis*, *d. ninomiyana*, *d. nisyatensis* and *makiyamai*.

*Measurements (mm.)—*

height	width	
23.0	8.0	Boshu, Recent
18.5	6.5	Sagami Bay, Recent

*Synonymy—*

- 1923 *Drillia dainichiensis* Yokoyama, Journ. Coll. Sci. Imper. Univ. Tokyo, vol. 45, pt. 2, p. 6, pl. 1, fig. 2.  
 1927 *Clavatula patruelis dainichiensis* (Yokoyama), Makiyama, Mem. Coll. Sci. Kyoto Imper. Univ. ser. B, vol. 3, pt. 1, p. 102, pl. 4, figs. 14, 15.  
 1952 *Clavatula (Paradrillia) dainichiensis* (Yokoyama), Hatai & Nisiyama, Sci. Rep. Tohoku Univ., Sendai, Japan, ser. 2, Geol., spec. vol. No. 3, p. 190.  
 1960 *Clavatula (Alticlavatula) dainichiensis* (Yokoyama), MacNeil, U.S. Geol. Surv. Prof. Paper 339, p. 110.

*Records*—JAPAN: Dainichi, Totomi (Dainichi Pliocene) (type locality), Recent: Sagami Bay (A. W. B. Powell, coll., ex K. Oyama), Boshu (Aust. Mus.).

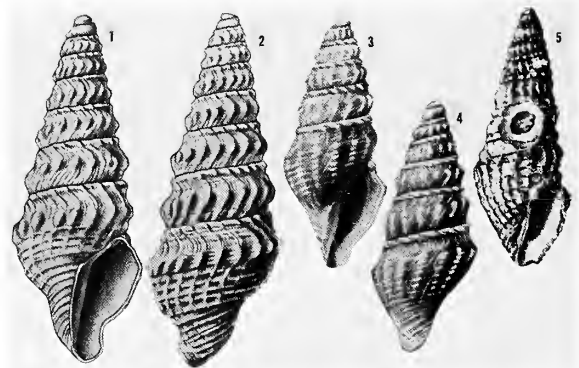


Plate 246. Figs. 1, 2, *Paradrillia agalma* (E. A. Smith). Ceylon, off Cape Comorin, 464 fathoms. 18.0 mm. (from Annandale & Stewart, 1909, pl. 20, figs. 1, 2). Figs. 3, 4, *Paradrillia celebensis* (Schepman). Makassar Strait, Indonesia, 1301 metres. 8.5 mm. (from Schepman, 1913, pl. 28, fig. 5). Fig. 5, *Paradrillia alluaudi* (Dautzenberg). Diego Suarez, Madagascar. 8.0 mm. (from Dautzenberg, 1932, pl. 1, fig. 1).

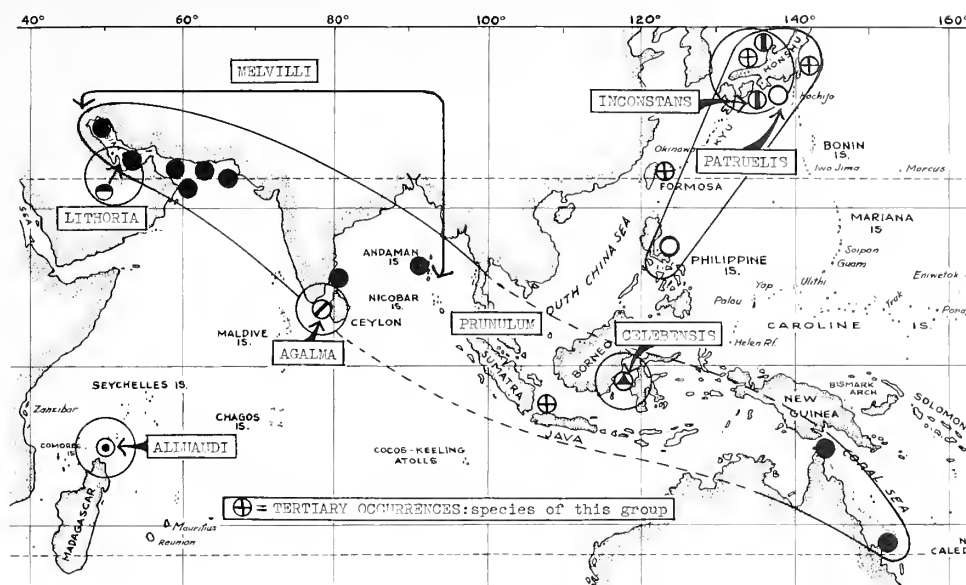


Plate 247. Geographical distribution of *Paradrillia patruelis* (E. A. Smith), *P. inconstans* (E. A. Smith) and subspecies *prunulum* (Melvill & Standen), *P. melvilli* Powell, new species, *P. lithoria* (Melvill & Standen), *P. alluaudi* (Dautzenberg), *P. agalma* (E. A. Smith) and *P. celebensis* (Schepman). Related Tertiary species are indicated by a cross within a circle.

### *Paradrillia agalma* (E. A. Smith, 1906)

(Pl. 246, figs. 1, 2)

**Range**—Ceylon, west of Cape Comorin in 464 fathoms, green mud and sand.

**Remarks**—This species resembles *patruelis* (Smith) in the latticed effect of the axial and spiral sculptural pattern, but the peripheral nodes are smooth elongated knobs, taller than wide, representing thickenings of the axials, which are more flexuous than in *patruelis*. The axials again thicken subsuturally, in the form of an irregularly gemmate fold.

The Japanese Pliocene *astutoida* Shuto, 1961 is a possible forerunner of *agalma*, differing from it, mainly in having a basal tuberculate sub-keel, as well as the peripheral one, and also in the spirals overriding the tubercles.

**Description**—Shell small, 18 mm. ( $\frac{3}{4}$  inch) in height, claviform, with tall spire, twice height of aperture plus canal, and truncated base. Whorls about 11, tip eroded; sculptured with flexuous thin axials, which thicken both at the periphery and at the suture. Axials crossed by spiral cords of about equal strength, except on the shoulder slope, where they are finer. Four closely spaced spiral threads in the interstices of the peripheral

nodes. Colour white, covered with a thin greyish periostracum.

#### Measurements (mm.)—

height	width
18.0	6.0

#### Synonymy—

1906 *Pleurotoma* (*Surcula*) *agalma* E. A. Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 162.

1909 *Pleurotoma* (*Surcula*) *agalma* Smith, Annandale & Stewart, Illustr. Zool. Investigator, Moll., pt. 6, pl. 20, figs. 1, 2.

**Types**—The unique holotype is in the Indian Museum, Calcutta.

### *Paradrillia alluaudi* (Dautzenberg, 1932)

(Pl. 246, fig. 5)

**Range**—Diego Suarez, Madagascar.

**Remarks**—From the illustration this species appears to be closely allied to *agalma* (Smith, 1906), from 464 fathoms off Cape Comorin, Ceylon. It has similar openly clathrate sculpture but the body-whorl is fuller over the region of the neck and the subsutural fold is heavier, with more prominent nodulation.

#### Measurements (mm.)—

height	width
8.0	3.0

#### Synonymy—

1932 *Drillia alluaudi* Dautzenberg, Journ. de Conch., vol. 76, p. 17, pl. 1, fig. 1.



**? *Paradrillia celebensis* (Schepman, 1913)**

(Pl. 246, figs. 3, 4)

*Range*—Makassar Strait, Indonesia, 1301 metres.

*Remarks*—This species is known to me only from Schepman's description and figure. Both the operculum and the radula are unknown but the shell has the facies of a *Paradrillia*.

*Description*—(original) "Shell small, sub-biconical, with short canal and subgradate spire, thin, subpellucid, white. Whorls  $6\frac{1}{2}$ , of which nearly 2 form a smooth, shining, convexly-whorled nucleus; subsequent whorls angular, excavated above, separated by a conspicuous, irregularly waved suture, with a rather strong rib just below it, with short bead-like folds, lower part of whorls with oblique ribs, 15 in number on last whorl, tubercled at their upper part below the excavation; moreover the basal part of whorls is crossed by faint spirals, 2 in number on penultimate, about 10 in slightly contracted last whorl, of which latter the upper ones are more conspicuous, bead-like in crossing the ribs, those on the canal plain, lastly the whorls are crossed by growth-lines. Aperture elongately oval, angular above, with a short, wide canal below; peristome thin, broken, according to growth-lines with a wide, rather deep sinus above, then considerably protracted, columellar side concave above, slightly tortuous below, with a conspicuous, appressed layer of enamel."

*Measurements (mm.)*—

height	width
8.5	3.5

*Synonymy*—

1913 *Surcula celebensis* Schepman, Siboga Exped., vol. 49e, pt. 5, p. 427, pl. 28, fig. 5.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—INDONESIA: Makassar Strait, 1301 metres, fine grey mud.

***Paradrillia djocdjocartae* (K. Martin, 1884)**

(Pl. 248, figs. 2, 3)

*Range*—Miocene of Java and upper Miocene and Pliocene of Sumatra.

*Remarks*—This species is known to me only from the original description and figure, which shows a tall-spined rather slender shell with a narrow elongated body-whorl, produced below into a short almost straight canal. Details of the spire-whorls (Martin's fig. 69a), show an intricate

crisp sculpture consisting of a bicingulate subsutural fold, a shallow rather narrow, steeply descending shoulder slope, a bicarinate, medially situated periphery and three weaker spiral cords between the peripheral carinae and the lower suture; the whole crossed by closely spaced axials which render gemmate all spirals at points of intersection. The shoulder slope concavity bears 3-4 fine wavy spiral lirae which are crenulated by axial growth lines. The species resembles the Recent *patruelis* but the spire outlines are straighter.

*Synonymy*—

1884 *Pleurotoma (Drillia) djocdjocartae* K. Martin, Samml.

Geol. Reichs-Mus., Leiden, vol. 3, p. 66, pl. 4, fig. 69.

1931 *Pleurotoma djocdjocartae* Martin, van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 218.

1960 *Clavatula (Alti-clavatula) djocdjocartae* (Martin), MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 110.

***Paradrillia serana* (P. J. Fischer, 1927)**

(Pl. 248, fig. 4)

*Range*—Pliocene of Ceram, Indonesia (type locality) and Neogene, upper part of Dingle Formation, Panay Island, Philippines.

*Remarks*—I have not seen material of this subspecies which is described by its author as being larger and not so slender as the Javanese Miocene typical species.

If Fischer's figure represents the constant form, then the sculpture of this subspecies shows a much heavier bicingulate subsutural fold, an equally heavy bicarinated periphery, a narrower shoulder concavity and only two spiral cords between the periphery and the lower suture. However Shuto (1969) elevated *serana* to full specific status on the evidence of the protoconch, which is blunt and of fewer whorls than those in *djocdjocartae*.

*Measurements (mm.)*—

height; 18-24

*Synonymy*—

1927 *Clavatula djocdjocartae* var. *serana* P. J. Fischer, Palaeont. von Timor, vol. 25, p. 98, pl. 214, fig. 77.

1931 *Pleurotoma djocdjocartae* var. *serana* (Fischer), van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 218.

1960 *Clavatula (Alti-clavatula) serana* (Fischer), MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 110.

1969 *Paradrillia serana* (Fischer), Shuto, Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., vol. 19, no. 1, p. 192, pl. 20, figs. 18-21; text fig. 36

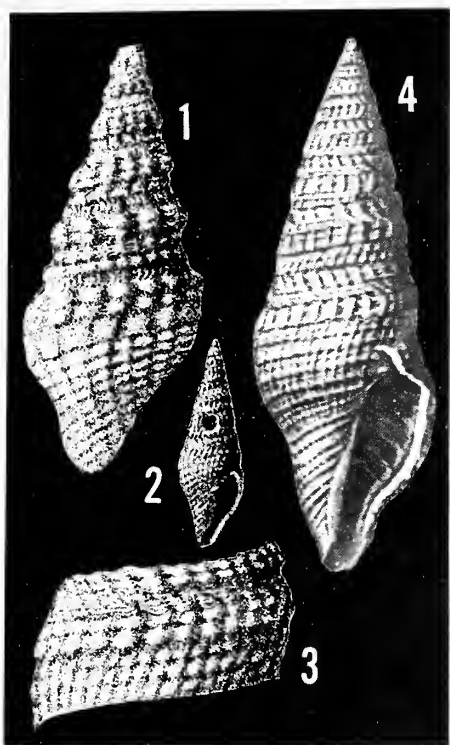


Plate 248. Fig. 1, *Paradrillia ermelingi* (K. Martin). Miocene of Ngembak, Java. Figs. 2, 3, *Paradrillia djocdjocartae* (K. Martin). Miocene of Java (from K. Martin, 1884, pl. 4). Fig. 4, *Paradrillia serana* (P. J. Fischer). Pliocene of Ceram (from Fischer, 1927, pl. 214, fig. 77).

### *Paradrillia ermelingi* (K. Martin, 1884)

(Pl. 248, fig. 1)

*Range*—Miocene of Ngembak, Java.

*Remarks*—So far as can be judged from Martin's description and figures this species is probably a *Paradrillia*, resembling *dainichiensis* in sculpture but with a proportionately wider shell. The peripheral carina in *ermelingi* is made up of two spiral rows of prominent nodes separated by a deep linear groove whereas in *dainichiensis* the nodes tend to be fused vertically to form a peripheral series of short stout axials.

#### *Synonymy*—

- 1884 *Pleurotoma* (*Drillia*) *ermelingi* K. Martin, Tiefbohr. auf Java, Samml. Geol. Reichs-Mus., Leiden, vol. 3, p. 67, pl. 4, fig. 70.  
1931 *Drillia ermelingi* (Martin), van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 216.

### *Paradrillia minoensis* (Shuto, 1961)

(Pl. 249, fig. 4)

*Range*—Japan, lower Upper Miocene.

*Remarks*—This species, which is very small, 6-9 mm., was compared by its author with both *astuta* (Yokoyama, 1928) and *astutoida* Shuto, 1961. Apart from its much smaller size, *minoensis* differs from both of the above mentioned species in having much finer spiral sculpture, an almost obsolete subsutural fold, only a very weak basal subangle, but the peripheral nodes, which are overridden by the spirals, are strong and pointed.

#### *Measurements* (mm.)—

height	width	
9.0	3.45	(paratype)
6.8	2.95	(holotype)

#### *Synonymy*—

- 1961 *Clavatula* (*Paradrillia*) *minoensis* Shuto, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol. vol. 11, pt. 2, p. 108, pl. 4, fig. 15, pl. 6, figs. 16, 17, text figs. 9, 10.

*Types*—The type material is in the Department of Geology, Kyushu University, Japan.

*Records*—JAPAN: south of tunnel near Yamaji, Mino mura, Koyu gun, Miyazaki Prefecture (Kawabaru member, lower upper Miocene).

### *Paradrillia astuta* (Yokoyama, 1928)

(Pl. 249, fig. 3)

*Range*—Japan, Pliocene.

*Remarks*—This species resembles the Recent *patruelis* (Smith), but is more slender and has fewer axials, with stronger and rather spinose peripheral nodes.

#### *Measurements* (mm.)—

height	width	
11.7	4.5	(holotype)

#### *Synonymy*—

- 1928 *Drillia astuta* Yokoyama, Journ. Fac. Sci. Imp. Univ. Tokyo, sec. 2, vol. 2, pt. 7, p. 341, pl. 66, figs. 14, 15.  
1952 *Cryptogemma astuta* (Yokoyama), Hatai & Nisiyama, Sci. Rep. Tohoku Univ., ser. 2, spec. vol. no. 3, p. 198.  
1961 *Clavatula* (*Paradrillia*) *astuta* (Yokoyama), Shuto, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol. vol. 11, pt. 2, p. 106, pl. 3, figs. 11, 12, text figs. 9, 10.

*Records*—JAPAN: Kounji and Uwae (Pliocene) (type locality); road cutting at Hagenoshita, Uwaye mura, Koyu gun, Miyazaki Prefecture (Takanabe member, lowest Pliocene).

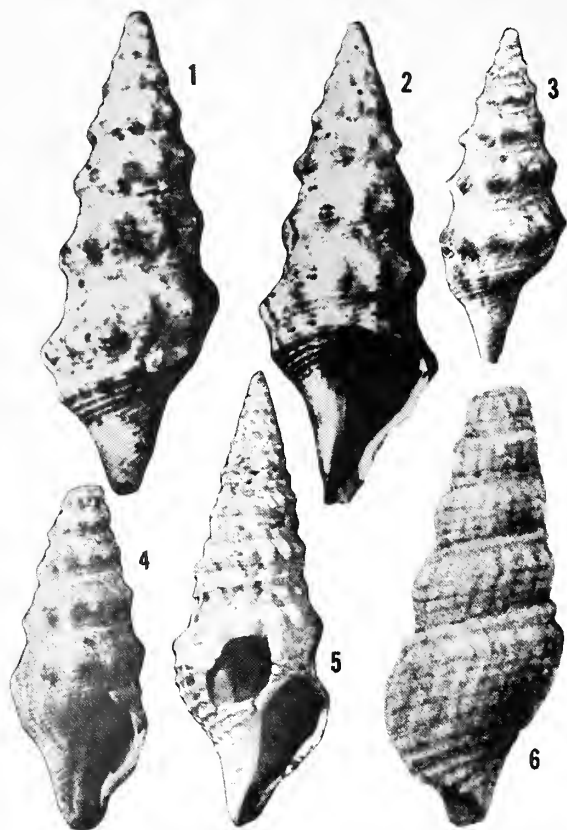


Plate 249. Figs. 1, 2, *Paradrillia astutoida* (Shuto). Japan, Takanabe member, Lowest Pliocene. 10.8 mm. Fig. 3, *Paradrillia astuta* (Yokoyama). Japan, Takanabe member, lowest Pliocene. 11.7 mm. Fig. 4, *Paradrillia minoensis* (Shuto). Japan, Yamaji, Lower Upper Miocene. 6.8 mm. Fig. 5, *Paradrillia convexiuscula* (Shuto). Japan, Hagenoshita, lowest Pliocene. 16.8 mm. (all from Shuto, 1961, pls. 3, 4, 5, & 10). Fig. 6, *Paradrillia boehmi* (K. Martin). Nanggulan beds, Miocene of Java (from K. Martin, 1914, pl. 1, fig. 13). 3-4 mm.

### *Paradrillia astutoida* Shuto, 1961

(Pl. 249, figs. 1, 2)

**Range**—Japan, lowest Pliocene.

**Remarks**—This species differs from *astuta* (Yokoyama) in having more prominent spiral sculpture and a basal tuberculate keel in addition to the peripheral one.

#### **Measurements (mm.)—**

height	width	
10.8	4.05	(holotype)

#### **Synonymy—**

1961 *Clavatula* (*Paradrillia*) *astutoida* Shuto, Mem. Fac. Sci. Kyushu Univ. Ser. D, Geol. vol. 11, pt. 2, p. 107, pl. 5, figs. 2, 3, text figs. 9, 10.

**Types**—The holotype is in the Department of Geology, Kyushu University, Japan.

**Records**—JAPAN: road cutting at Nihonmatsu, Takanabe machi, Koyu gun, Miyazaki Prefecture (Takanabe member, lowest Pliocene).

### *Paradrillia boehmi* (K. Martin, 1914)

(Pl. 249, fig. 6)

**Range**—Nanggulan Miocene of Kali Puru, Java.

**Remarks**—This unique fossil was founded upon an incomplete specimen of about 3-4 mm. in height, minus the apical whorls and with a damaged anterior end. However, the tall spire, apparently truncated body-whorl and style of sculpture suggests a species of *Paradrillia*, not unlike *inconstans prunulum* (Melvill & Standen).

In 1931, Martin (Dienst. Mijnb. Ned.-Indie Wetens. Meded., No. 18, pl. 1, fig. 13) substituted a revised figure for his *boehmi* of 1914, but the 1931 version appears to represent a shell, not only different specifically from his 1914 proposition, but also probably belonging to a different subfamily. Compared with *boehmi* typical, the 1931 shell, apart from its long canal (the original *boehmi* has the anterior end incomplete), has lower, more tightly coiled whorls, a heavier sub-sutural fold, a much more deeply excavated shoulder sulcus and a different sculptural pattern, which is clathrate, with the axials dominant. The 1931 shell, which has the outer lip damaged, suggests in its general facies, the clavinid *Cras-sispira*.

#### **Synonymy—**

1914 *Surcula boehmi* K. Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2, pt. 4, p. 115, pl. 1, figs. 13, 13a.

1919 *Surcula boehmi* K. Martin, Palaeozool. Kenntnis von Java, Leiden, p. 74.

1931 *Surcula boehmi* Martin, van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 219.

### *Paradrillia convexiuscula* (Shuto, 1961)

(Pl. 249, fig. 5)

**Range**—Japan, lowest Pliocene.

**Remarks**—Shuto considered this fossil to be a subspecies of von Martens' *Drillia elachystoma*, a Recent species from off East Africa in 638 metres. However, von Martens' species clearly belongs to the *Clavinae*, and although it is immature, without an adult lip, the style of sculpture, smooth unmarginated shoulder area, and relatively large size, 49 mm., shows it to be an *Inquisitor*.



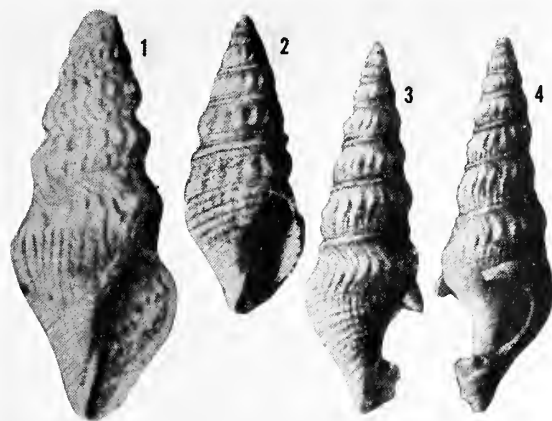


Plate 250. Fig. 1, *Paradrillia kakegawensis* (Makiyama). Japan, Kakegawa Series, Lower Pliocene. 8.6 mm. Fig. 2, *Paradrillia himea* (Makiyama). Japan, Kakegawa Series, Lower Pliocene. 6.2 mm. (both from Makiyama, 1927, pl. 4, fig. 5, and pl. 5, fig. 3). Figs. 3, 4, *Paradrillia nivalioides* (Yokoyama). Pliocene of Japan. 16.0 mm. (from Yokoyama, 1920, pl. 1, fig. 27).

Shuto's subspecies, is however, definitely a *Paradrillia*, for it has the axials and spirals latticed, a prominent subsutural fold and the shoulder concavity is distinctly spirally lirate. Shuto's second correlation, with *dainichiensis*, is more realistic, in fact the two seem to be quite closely related, the main differences for *convexuscula* being a taller spire, more erect and bluntly rounded axials, crossed by stronger spirals, and a weaker basal angulation.

#### Measurements (mm.)—

height	width	
16.8	5.9	(holotype)

#### Synonymy—

- 1961 *Clavatula* (*Paradrillia*) *elachystoma convexiuscula* Shuto, Mem. Fac. Sci. Kyushu Univ. Ser. D, Geol. vol. 11, pt. 2, p. 109, pl. 6, fig. 15, pl. 10, f. 18, text figs. 9, 10.

*Types*—The holotype is in the Department of Geology, Kyushu University, Japan.

*Records*—JAPAN: road cutting at Hagenoshita, Uwayemura, Koyu gun, Miyazaki Prefecture (lower part of Takanabe member, lowest Pliocene).

#### *Paradrillia himea* (Makiyama, 1927)

(Pl. 250, fig. 2)

*Remarks*—This species was stated by its author to be distinguishable from "*consimilis* Smith" (i.e. "*dainichiensis viva* Makiyama" auct.), by its smaller, broader and less acute shell, with a less granulate sculpture and by the absence of the fine spiral threads.

#### Measurements (mm.)—

height	width
6.13	2.41

#### Synonymy—

- 1927 *Clavatula himea* Makiyama, Mem. Coll. Sci. Kyoto Imper. Univ. ser. B, vol. 3, no. 1, p. 101, pl. 5, fig. 3.  
1952 *Clavatula himea* Makiyama, Hatai & Nisiyama, Sci. Rep. Tohoku Univ. Sendai, Japan, ser. 2 (Geol.), spec. vol. no. 3, p. 191.

*Records*—JAPAN: Honohasi (Kakegawa series, Dainichi Pliocene).

#### *Paradrillia kakegawensis* (Makiyama, 1927)

(Pl. 250, fig. 1)

*Remarks*—Shell similar to *patruelis* Smith but of smaller adult size. Makiyama remarked that his species is closely allied to "*C. patruelis dainichiensis* (Yokoyama, 1923), especially in its general outline and in its sculpture, which however, is finer in *kakegawensis*".

*Description*—Shell turriculate, high and acute, base truncated. Protoconch depressed, smooth, of two whorls. Sculpture of the same pattern as in *patruelis* but finer, and the axial plications more numerous.

#### Measurements (mm.)—

height	width
8.6	4.0

#### Synonymy—

- 1927 *Clavatula kakegawensis* Makiyama, Kyoto Imper. Univ. Coll. Sci. Mem. ser B, vol. 3, no. 1, p. 100, pl. 4, fig. 5.  
1960 *Clavatula* (*Alticlavatula*) *kakegawensis* (Makiyama), MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 110.  
1952 *Clavatula kakegawensis* (sic) Makiyama, Hatai & Nisiyama, Sci. Rep. Tohoku Univ., Sendai, Japan, ser. 2 (Geol.), spec. vol. no. 3, p. 191.

*Records*—JAPAN, Tenmoyama (Kakegawa series, lower Pliocene), OKINAWA (Chinen sand, Pliocene).

*Types*—The holotype is in the Kyoto Imperial University, Japan.

#### *Paradrillia nivalioides* (Yokoyama, 1920)

(Pl. 250, figs. 3, 4)

*Range*—Pliocene to Recent, Japan.

*Remarks*—This species resembles both the Recent *patruelis* and the Pliocene-Recent *dainichiensis*. From both, it differs in having a much more prominent, and smooth, subsutural margining cord, and the axial sculpture is more dense, flowing from suture to suture, and over the base, in a flexuous manner, but thickened

medially, in the form of relatively long fold-like axials. Most points of intersection between the axials and the equally dense spiral sculpture are finely gemmate.

*Description*—(original) “Shell small, turrete, with body-whorl nearly one-half the shell-height; whorls eleven, shouldered with the exception of two embryonic ones which are convex; shoulders furnished with obliquely elongated tubercles separated by somewhat wider interspaces; surface above shoulders flatly concave, transversely striated, with a subsutural thread in the upper part; surface below shoulders nearly perpendicular with two vertical threads proceeding from each tubercle and crossed by a few unequal transverse threads with cross-points more or less tubercular. On the body-whorl, the infra-tubercular vertical threads are crossed by many unequal, rather distant, transverse ones, so that the whole surface appears to be cancellated, with cross-points more or less tubercular as in the upper whorls. Inner lip smooth, with a thin callosus, somewhat flexuous. Canal short, recurved. Sinus rather shallow.”

*Measurements (mm.)*—

height	width	
16.0	4.5	holotype
14.0	4.0	

*Synonymy*—

- 1920 *Pleurotoma (Drillia) nivalioides* Yokoyama, Journ. Coll. Sci. Imper. Univ. Tokyo, vol. 39, pt. 6, p. 39, pl. 1, fig. 27.  
 1954 *Paradrillia nivalioides* (Yokoyama), Taki & Oyama, Palaeont. Soc. Japan, spec. papers, no. 2, p. 25.

*Records*—JAPAN: Koshiba Zone (type locality) and Nagatsuma Zone, upper Musashino of Oji (Pliocene). Recent: from low-water to 250 metres (Taki & Oyama).

*Paradrillia taiwanensis* (Nomura, 1935)

*Range*—Pliocene of Taiwan.

*Remarks*—In dealing with material from Okinawa, ascribed to this species, MacNeil (1960, l.c.) remarked as follows:—“The Okinawan form is separable from *C. (A.) dainichiensis* (Yokoyama, 1923) . . . by the same difference that Makiyama recognized for typical *C. (A.) kakegawensis*, namely that it has about 26 axials per whorl as opposed to fifteen for *dainichiensis*; *patruelis* has fourteen. Nomura states that the axials on *C. (A.) taiwanensis* (Nomura, p. 116, pl. 6, f. 60) number seventeen on the subsutural slope, but split to form about 25 on the periphery. It is possible that *taiwanensis* and *kakegawensis* will prove to be one species.”

*Measurements (mm.)*—

height	width
17.0	5.5

*Synonymy*—

- 1935 *Clavatula taiwanensis* Nomura, Sci. Rep. Tohoku Imper. Univ., Sendai, Japan, ser. 2 (Geol.), vol. 18, pt. 2, p. 116, pl. 6, figs. 59a, b.  
 1960 *Clavatula (Alticlavatula) taiwanensis* (Nomura), MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 110.

*Types*—Holotype in the Institute of Geology and Paleontology, Sendai, Japan.

*Records*—TAIWAN (Formosa), Byoritu Beds (Pliocene).

**Genus Vexitomina Powell, 1942**Type: *Drillia metcalfei* Angas, 1867

After years of conflicting opinions regarding the systematic location of this genus it now seems to rest more happily in a new alignment as a near relative of the Asian genus *Paradrillia*. Finlay, 1924 (Trans. N. Z. Inst., 55, p. 516) noted the apparent close relationship between the New Zealand benthic *Drillia optabilis* Murdoch & Suter, 1906 and the New South Wales *Drillia metcalfei* Angas, 1867; at the same time claiming them both to be Recent members of the otherwise Austro-Neozelanic Tertiary genus *Anstro-toma*. This association was accepted by me (1942, Bull. No. 2, Auck. Inst. Mus., p. 77), except that the two Recent species referred to above, were segregated under a new genus *Vexitomina*.

Laseron (1954, The N. S. W. Turridae, pp. 11-13) admitted seven New South Wales species of *Vexitomina*, describing three of them as new, but he compared the genus with *Epidirona*, a member of the Turridae. However, the position of the apex of the sinus, which is well above the periphery, is against inclusion in the Turridae, and the absence, for the most part, of a distinct parietal callus-pad or tubercle, and of a stromboid-notch in the lower outer lip, are features not in accord with the Clavinae. At most, notably in *coxi*, *snavis* and *regis* there is sometimes a slight to moderate thickening of the upper parietal callus, but this appears to be a gerontic development, not typical of the genus.

When specimens of *Paradrillia patruelis* (E. A. Smith, 1875) are placed alongside specimens of *Vexitoma metcalfei* (Angas, 1867), there appear to be no points of generic dissimilarity so far as shell structures are concerned. They are co-equal in size, style of protoconch, form of adult sculpture, sinus, and in fact most other features except for the operculum, which is clavatulid in *Paradrillia* but leaf-shaped with a terminal nucleus in *Vexitomina*, and also in a tendency towards liration of the inside of the outer lip in *Paradrillia* but not in *Vexitomina*.

This is a parallel to the *Turricula-Comitas* anomaly, and provides still another example of the vexed question of pairing in turrid genera, as shown in such instances as *Inquisitor* + *Pseudoinquisitor* and *Tomopleura* + *Maoritomella* in the Clavinae, and *Lophiotoma* + *Lophioturris* in the Turridae.

A further point of analogy between the *Paradrillia-Vexitomina* and *Turricula-Comitas* "generic pairs" emerges, and that is in the respective distributional patterns of these groups.

In the *Turricula-Comitas* groups the former with its clavatulid operculum is of warm shallow water distribution, and the latter with its leaf shaped terminal apiced operculum, mostly of temperate and deep colder water dispersal (Archibenthic and deeper, which means cold water in the case of species from the depths, even in equatorial locations).

Similar geographical patterns are revealed with *Paradrillia* and *Vexitomina*, in that the former, with the clavatulid operculum is tropical and the latter, with the leaf-shaped terminal apiced operculum is mainly of temperate distribution. A possible exception is *regis*, the operculum of which is unknown.

Only a detailed examination of relevant material, at present unavailable, will resolve this problem, but for the present, radical opercular differences are accepted as indicative of generic dissimilarity.

*Description*—Shell medium sized, 15-33 mm. (½-1¼ inches) in height. Claviform, with tall spire and truncated anterior end, but without a definite parietal callus pad or tubercle, except occasionally in a gerontic state. Sinus rather shallow, with a broadly rounded apex, occupying the middle of the shoulder slope, not subtubular or ridge-margined. Protoconch of 2½ smooth whorls, usually developing a weak low-set keel towards its termination, which is defined by a forwardly projected weak terminal axial growth line (Pl. 242, fig. 3). This is followed by numerous weak axials gradually increasing in strength along with the spiral keel, as the post-nuclear sculpture develops. Adult sculpture of axials crossed by spirals in varying relative strengths, usually developed into peripheral nodes or pointed tubercles in single or double series. Outer lip not variced; anterior canal very short, and shallowly notched. Operculum leaf-shaped with a terminal nucleus.

*Range*—New South Wales, Victoria, Tasmania, northern New Zealand and Indo-Pacific, Mauritius, East Indies, Philippines and Loyalty Islands.

**Synonymy—**

1942 *Vexitomina* Powell, Bulletin no. 2, Auckland Institute and Museum, p. 77. Type by original designation: *Drillia metcalfei* Angas, 1867.



### Key to species of *Vexitomina*

- A. Sculpture with spirals dominant
  - a. With one row of peripheral nodes
    - Peripheral nodes on raised flange
      - Nodes narrow; on all cords
        - Unicoloured, except white peripheral zone  
..... *metcalfei* (Angas)
      - Nodes bluntly rounded; on all cords
        - Colour flames, red-brown on white *regia* (Reeve)
    - Peripheral nodes not on raised flange
      - Nodes large and bluntly rounded *pilazona* Laseron
      - Nodes large and pointed ..... *torquata* Laseron
  - b. With two rows of peripheral nodes
    - Shell slender
      - Nodes weak, rows oblique ..... *coxi* (Angas)
    - Shell relatively broad
      - Nodes strong, rows vertical ..... *garrardi* Laseron
- B. Sculpture with axials dominant
  - Axials long, fold-like
    - Axials weak, strongest medially *coriorudis* (Hedley)
    - Axials strong throughout ..... *suavis* (E. A. Smith)
- C. Sculpture clathrate
  - Spiral cords subequal, 3-4 on spire-whorls  
..... *optabilis* (Murdoch and Suter)

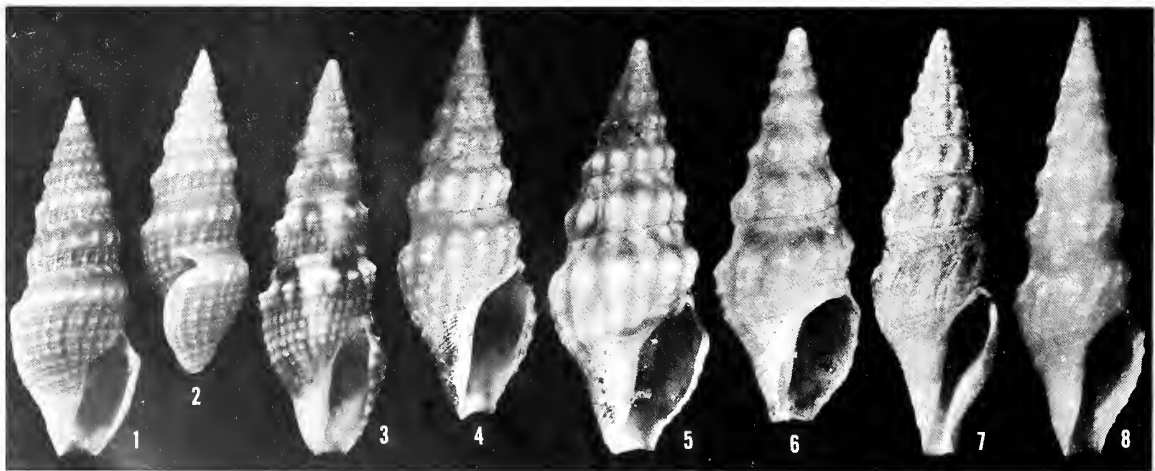


Plate 251. Australian *Vexitomina*. Figs. 1, 2, *Vexitomina metcalfei* (Angas). New South Wales, Port Jackson, dredged. 20 and 19 mm. Fig. 3, *Vexitomina regia* (Reeve). Philippine Islands. 31.0 mm. Fig. 4, *Vexitomina garrardi* Laseron. Holotype, New South Wales, dredged Two fold Bay. 25.0 mm. Fig. 5, *Vexitomina pilazona* Laseron. Holotype, New

South Wales, 10-15 fathoms, Twofold Bay. 20.0 mm. Fig. 6, *Vexitomina torquata* Laseron. Holotype, New South Wales, 30-50 fathoms off Sydney. 16.0 mm. Fig. 7, *Vexitomina coriorudis* (Hedley). New South Wales, off Sydney, 300 fathoms. 23.0 mm. Fig. 8, *Vexitomina coxi* (Angas). New South Wales, Port Jackson. 33.0 mm.

**Vexitomina coriorudis (Hedley, 1922)**

(Pl. 251, fig. 7)

**Range**—New South Wales, Australia, 30-300 fathoms.

**Measurements (mm.)—**

height	width	
23.0	7.0	holotype
28.0	10.0	Laseron

**Synonymy—**

1922 *Inquisitor coriorudis* Hedley, Rec. Aust. Mus., vol. 13, no. 6, p. 237, pl. 43, fig. 25.

1954 *Vexitomina coriorudis* (Hedley), Laseron, The N. S. W. Turridae, p. 13, pl. 2, figs. 44-46.

**Types**—The holotype is in the Australian Museum, Sydney.

**Records**—NEW SOUTH WALES: 27 miles east of Sydney, 300 fathoms (type locality); Crookhaven, 30-35 fathoms; off Port Stephens, 30 fathoms (Laseron).

**Vexitomina coxi (Angas, 1867)**

(Pl. 251, fig. 8)

**Range**—New South Wales, Victoria and Tasmania, Australia.

**Measurements (mm.)—**

height	width	
33.0	—	(Hedley, 1922)
27.0	7.5	(Laseron, 1954)

**Synonymy—**

1867 *Drillia coxi* Angas, Proc. Zool. Soc., London, p. 113, pl. 13, fig. 15.

1879 *Drillia agnewi* Tenison-Woods, Proc. Roy. Soc. Tasm. for 1878, p. 36.

1922 *Inquisitor coxi* (Angas), Hedley, Rec. Aust. Mus., vol. 13, no. 6, p. 238, pl. 43, fig. 26.

1954 *Vexitomina coxi* (Angas), Laseron, The N. S. W. Turridae, p. 12, pl. 2, figs. 40, 41.

1962 *Vexitomina coxi* (Angas), Macpherson & Gabriel, Mar. Moll. of Victoria, Melbourne, p. 232.

**Types**—The holotype of *coxi* is in the British Museum (Nat. Hist.) and that of *agnewi* in the Tasmanian Museum, Hobart.

**Records**—NEW SOUTH WALES: Port Jackson (type of *coxi*). TASMANIA: (type of *agnewi*). VICTORIA: Portland and Western Port (Macpherson & Gabriel).

**Vexitomina garrardi Laseron, 1954**

(Pl. 251, fig. 4)

**Range**—Continental shelf of southern New South Wales, Australia.

**Remarks**—This species and *coxi* have a double row of peripheral nodes but the former is a much narrower shell than the latter.

**Measurements (mm.)—**

height	width
25.0	7.5

**Synonymy—**

1954 *Vexitomina garrardi* Laseron, The N. S. W. Turridae, p. 13, pl. 2, figs. 42, 43.

**Types**—The holotype is in the Australian Museum, Sydney.

**Records**—NEW SOUTH WALES: Twofold Bay, dredged (type locality); Jervis Bay; common on the continental shelf of southern New South Wales (Laseron, 1954).

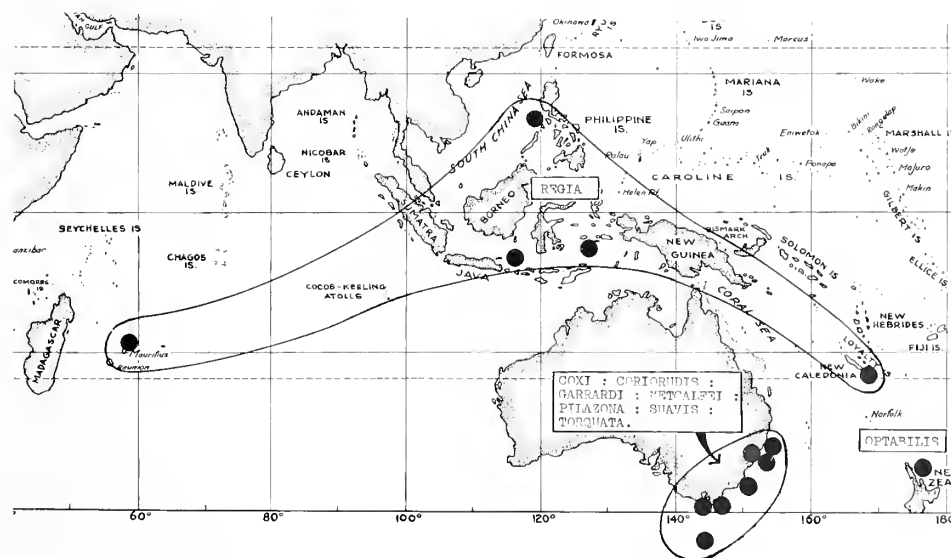


Plate 252. Geographical distribution of *Vexitomina regia* (Reeve), *V. coriorudis* (Hedley), *V. coxi* (Angas), *V. garrardi* Laseron, *V. metcalfei* (Angas), *V. optabilis* (Murdoch &

Suter), *V. pilazona* Laseron, *V. suavis* (E. A. Smith) and *V. torquata* Laseron.

***Vexitomina metcalfei* (Angas, 1867)**

(Pl. 251, figs. 1, 2)

*Range*—New South Wales, from Port Stephens to Jervis Bay; down to 10 fathoms.

*Measurements* (mm.)—

height	width
19.0	7.0
20.0	8.5

*Synonymy*—

- 1867 *Drillia metcalfei* Angas, Proc. Zool. Soc., London, p. 113, pl. 13, fig. 16.  
 1922 *Inquisitor metcalfei* (Angas), Hedley, Rec. Aust. Mus., vol. 13, no. 6, p. 243, pl. 44, figs. 34, 35.  
 1942 *Vexitomina metcalfei* (Angas), Powell, Bull. no. 2, Auck. Inst. Mus., p. 77.  
 1954 *Vexitomina metcalfei* (Angas), Laseron, The N. S. W. Turridae, p. 12, pl. 2, figs. 35-37.

*Types*—The holotype is in the British Museum (Natural History).

*Records*—NEW SOUTH WALES: Port Jackson (type locality); Port Stephens to Jervis Bay (Laseron, 1954).

***Vexitomina optabilis* (Murdoch & Suter, 1906)**

*Range*—New Zealand, off Great Barrier Island, 110 fathoms.

*Remarks*—Although the apical whorls of this shell are eroded the adult features are closely in accord with those of the genus.

*Measurements* (mm.)—

height	width
10.7	3.95

*Synonymy*—

- 1906 *Drillia optabilis* Murdoch & Suter, Trans. N. Z. Inst., vol. 38, p. 283, pl. 21, fig. 9.  
 1924 *Austrotoma optabilis* (Murdoch & Suter), Finlay, Trans. N. Z. Inst., vol. 55, p. 516.  
 1942 *Vexitomina optabilis* (Murdoch & Suter), Powell, Bull. no. 2, Auck. Inst. Mus., p. 78.

*Types*—The holotype is in the Dominion Museum, Wellington.

***Vexitomina pilazona* Laseron, 1954**

(Pl. 251, fig. 5)

*Range*—New South Wales, Twofold Bay, 10-15 fathoms.

*Remarks*—In general form this species approaches *metcalfei* but differs in the sculpture, particularly in the row of peripheral nodes which are fewer, stronger, more rounded and not upon a raised peripheral flange.

*Measurements* (mm.)—

height	width
20.0	8.0

*Synonymy*—

- 1954 *Vexitomina pilazona* Laseron, The N. S. W. Turridae, p. 12, pl. 2, figs. 38, 39.

*Types*—The holotype is in the Australian Museum, Sydney.

***Vexitomina suavis* (E. A. Smith, 1888)**

*Range*—New South Wales, off Cape Three Points, 41-50 fathoms (type locality); Victoria, Western Port (Macpherson & Gabriel).

*Remarks*—Laseron (1954, l.c.) cast doubts regarding the identification of the Western Port record. I have not examined the type of this species but from Hedley's illustration (1922, l.c.) the generic location seems to be reasonable. The one doubtful feature is the heavy upper parietal callus, but to a lesser extent this style of ridge-margined callus occurs also in *coxi* (Angas). It is a long even heavy application of callus, not in the form of a clavinid tubercle.

*Measurements* (mm.)—

height	width	
12.0	4.0	(holotype)
14.5	5.6	(Laseron)

*Synonymy*—

- 1888 *Pleurotoma* (*Drillia*) *suavis* E. A. Smith, Ann. Mag. Nat. Hist., ser. 6, vol. 2, p. 305.  
 1903 *Drillia prosuavis* Hedley, Mem. Aust. Mus., vol. 4, p. 389, text fig. 103 (not 102, error), *nom. nov.* for *Pl. (Drillia) suavis* Smith, 1888 (non *Drillia suavis* Hervier, 1895), *nom. nov.* for Smith's species unnecessary.  
 1922 *Inquisitor suavis* (Smith), Hedley, Rec. Aust. Mus., vol. 13, no. 6, p. 44, fig. 37.  
 1954 *Vexitomina suavis* (Smith), Laseron, The N. S. W. Turridae, p. 13, pl. 2, fig. 47.

*Types*—The holotype is in the British Museum (Natural History).



**Vexitomina regia** (Reeve, 1842)

(Pl. 251, fig. 3)

*Range*—Mauritius, East Indies, Philippines and Loyalty Islands.

*Remarks*—This species is easily recognised by its colour pattern of broad vertical flames of bright reddish-brown on a creamy-white ground; strongly sculptured with closely spaced nodulose spiral cords.

The species seems to qualify for inclusion in *Vexitomina* rather than in any of the clavinid genera. The non-lirate interior of the aperture precludes *Paradrillia*, and although there is a clavinid-like parietal callus-pad, this feature does occur in several species of the *Vexitomina* range. Further, a Stromboid-notch in the outer lip, which is a feature of most clavinids, is absent from *regia*. Hedley's reference of *rougeyroni* (= *regia*), to *Turridrupa* is untenable since that genus has a different style of protoconch as well as one or two cords or threads bisecting the shoulder concavity.

*Description*—Shell claviform, of moderate size, 25-29 mm. (1-1 $\frac{1}{8}$  inches) in height. Spire tall and slender, 1 $\frac{1}{2}$  times height of the aperture plus canal. Body-whorl truncated, with a short, rather widely open, shallowly notched anterior canal. Whorls 11 $\frac{1}{2}$ -12, including a small smooth, subglobose protoconch of about two whorls, tip asymmetric, and followed by a straight, vertical-sided whorl, which shows traces of brephic axials and incipient spirals. All available specimens have the nuclear whorls somewhat eroded. Spire-whorls angled just above middle height; sculptured firstly with a prominent rounded nodulose subsutural fold, followed by a rather wide shoulder slope, which is moderately concave and incised by spiral lines to form three low flattened relatively broad cords, the whole crossed by dense concavely arcuate growth striae. Peripheral angle formed by a prominent rounded cord, bearing strong closely spaced bluntly rounded nodes; between this and the lower suture are 2-3 similar, but slightly weaker, nodulose spiral cords. On the body-whorl from below the periphery there are about ten nodulose cords, the fifth slightly stronger, causing a weak basal subangle; five weak plain oblique flattened cords on the anterior fasciole, separated by linear grooves. Aperture rather narrow with parallel sides, smooth

within. Outer lip with a moderately deep and rather wide U-shaped sinus, which occupies the whole of the shoulder concavity. Outer lip gently arcuate and almost vertical, without a stromboid-notch. Colour pattern as described above. Inner lip with a parietal callus pad.

*Measurements* (mm.)—

height	width	
31.0	11.0	Philippines (D. Dan)
30.5	11.0	Lifu, Loyalty Islands
27.5	9.0	Lifu, Loyalty Islands

*Synonymy*—

- 1842 *Pleurotoma regia* Reeve, Conch. Syst., vol. 2, p. 187, pl. 233, fig. 7.  
 1843 *Pleurotoma regia* Reeve, Conch. Iconica, vol. 1, sp. 75, pl. 9, fig. 75.  
 1884 *Drillia regia* Beck, Tryon, Manual of Conch., vol. 6, p. 201, pl. 11, fig. 80.  
 1913 *Drillia regia* (Beck) Reeve, Schepman, Siboga Exped. Monog. 49e, pt. 5, p. 413.  
 1894 *Pleurotoma rougeyroni* Soubervie, Journ. de Conch., vol. 21, p. 187, pl. 7, fig. 1.  
 1922 *Turridrupa rougeyroni* (Soubervie), Hedley, Rec. Austr. Mus., vol. 13, no. 6, p. 226.

*Types*—The type of *regia* was stated by Reeve to be in the King of Denmark's collection, Copenhagen. The holotype of *rougeyroni* is in the Mus. d'Hist. Nat., Bordeaux.

*Records*—MAURITIUS (Powell coll., Auck. Mus.). EAST INDIES, between Bahuluwang and Tambolungan, south of Saleyer, 8-10 metres; east of Sailus Besar, Paternoster Islands, 36 metres (Schepman, 1913); Amboina (Reeve, 1843; locality unknown in Reeve, 1842). PHILIPPINES: (D. Dan, 1964). LOYALTY ISLANDS: Lifu (type locality of *rougeyroni*; Austr. Mus.; Powell coll., Auck. Mus.).

**Vexitomina torquata** Laseyron, 1954

(Pl. 251, fig. 6)

*Range*—New South Wales, 30-50 fathoms off Sydney (type locality); off Crookhaven, 30-35 fathoms.

*Remarks*—Similar to *suavis* (E. A. Smith, 1888) but with the peripheral nodes much more prominent and pointed.

*Measurements* (mm.)—

height	width
16.0	6.0

*Synonymy*—

- 1954 *Vexitomina torquata* Laseyron, The N. S. W. Turridae, p. 13, pl. 3, figs. 48, 49.

*Types*—The holotype is in the Australian Museum, Sydney.

*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*

## Genus *Nihonia* MacNeil, 1960

Type: *Nihonia shimajiriensis* MacNeil, 1960

It seems certain that this generic name, proposed for a Miocene species from Okinawa, is also applicable to the well known Recent Japanese *mirabilis* (Sowerby, 1914), its Tertiary congeners and the equally well known Recent *australis* (Roissy) from the South China Sea and its Recent and Tertiary relatives.

Both *mirabilis* and *australis*, formerly assigned to *Surcula* (i.e. *Turricula*), have been referred both to an American Eocene-Oligocene genus *Orthosurcula* and, latterly, to *Fusosurcula*, a manuscript name of Kuroda's, first published as a nude name by Kira, 1954 in his "Coloured Illustrations of the Shells of Japan".

I have not seen the type species of *Nihonia* but MacNeil's diagnosis of the genus fits the *mirabilis-australis* group equally well. Briefly the diagnosis of *Nihonia* is:—anal sinus deeply U-shaped, about  $1\frac{1}{2}$  times as deep as wide, and situated on the subsutural slope. Protoconch sub-naticoidal and unsculptured, of about  $1\frac{1}{2}$  whorls. Post-nuclear sculpture of coarse spiral lirations or cords.

That MacNeil had the *mirabilis-australis* group in mind when he proposed *Nihonia* is shown by his reference to *Nihonia* of the Japanese Pliocene species *pervirgo* (Yokoyama, 1928), which is almost certainly related to the Recent *mirabilis*.

The genus *Orthosurcula*, formerly in use for these East Asiatic shells, is almost devoid of sculpture in the type species *longiforma* Aldrich, which has a protoconch of 3-3½ smooth polished whorls, followed by about three fourths of a whorl of sharp oblique arcuate axial costae. Also the sinus in *longiforma* differs from that of *Nihonia* in being much shallower, the upper slope descending almost straight at an angle of about

30 degrees to a broadly arcuate apex, after which the lower slope is almost immediately confluent with the forwardly produced outer lip.

Shells of *Nihonia* range up to 100 mm. (4 inches) in height (*australis*). They are narrowly-fusiform, with a tall spire and a long straight un-notched anterior canal. The protoconch is small of  $1\frac{1}{2}$ -2 whorls, the first whorl loosely coiled with the tip tilted and inrolled. In *mirabilis* the protoconch of two whorls terminates with several indistinct sigmoid brephic axials, insinuated above and protractively arcuate below. In *australis* the nuclear whorls are about  $1\frac{1}{2}$  and these are followed by almost one whorl of closely spaced brephic axials. The adult sculpture is of numerous rounded spiral cords with intermediate threads, the whole surface crossed by fine axial growth lines, which are interstitial only, in *mirabilis*, but delicately decussate the spirals as well, in *australis*. Sinus deep, rather narrowly constricted at its apex, then swinging forward in a great sweeping arc, confluent with the outer lip. The operculum (*australis*), is leaf-shaped with a terminal nucleus.

In *Comitas*, which also has a leaf-shaped operculum with a terminal nucleus, the sculpture is strongly axial and the sinus is much shallower. In *Turricula* the operculum has a medio-lateral nucleus.

### Synonymy—

1954 *Fusosurcula* (Kuroda ms.) in Kira, Coloured Illustrations of the Shells of Japan, pl. 35, fig. 11, for *Pleurotoma* (*Surcula*) *mirabilis* Sowerby, 1914 (*nomen nudum*).

1960 *Nihonia* MacNeil, U.S. Geological Survey Professional Paper, no. 339, p. 105. Type by original designation: *Nihonia shimajirensis* MacNeil, 1960.

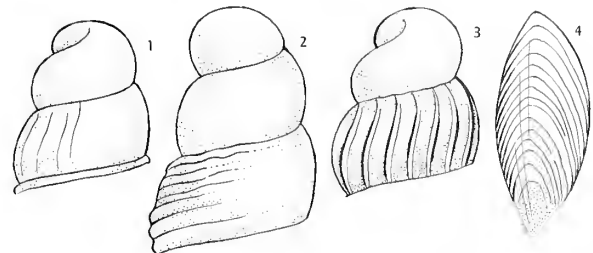


Plate 253. Protoconchs of *Nihonia*. Figs. 1, 2, *Nihonia mirabilis* (Sowerby). Japan. Fig. 3, *Nihonia australis* (Roissy). Hong Kong. Fig. 4, operculum of *Nihonia australis* (Roissy). Hong Kong.



Key to species of *Nihonia*

- Spire whorls rounded
  - Shell narrow, spire angle 25-29°
    - Spiral sculpture only
      - Spire angle 25° ..... *soyomaruae* (Otuka)
      - Spire angle 28-29° ..... *mirabilis* (Sowerby)
  - Shell wide, spire angle 30-35°
    - Spirals delicately gemmate
      - Axial interstitial threads strong ..... *australis* (Roissy)
    - Spirals as rows of distinct gemmules
      - Axial sculpture obsolete ..... *sucabumiana* (K. Martin)
    - Spirals overriding axial folds
      - Axials strong above, subobsolete below
        - ..... *circumstricta* (von Martens)
- Spire whorls pagodiform
  - Shell moderately wide, spire angle 30-31°
    - Spiral sculpture only
      - Periphery unicarinate ..... *shimajiriensis* MacNeil
      - Periphery bicarinate ..... *pervirgo* (Yokoyama)

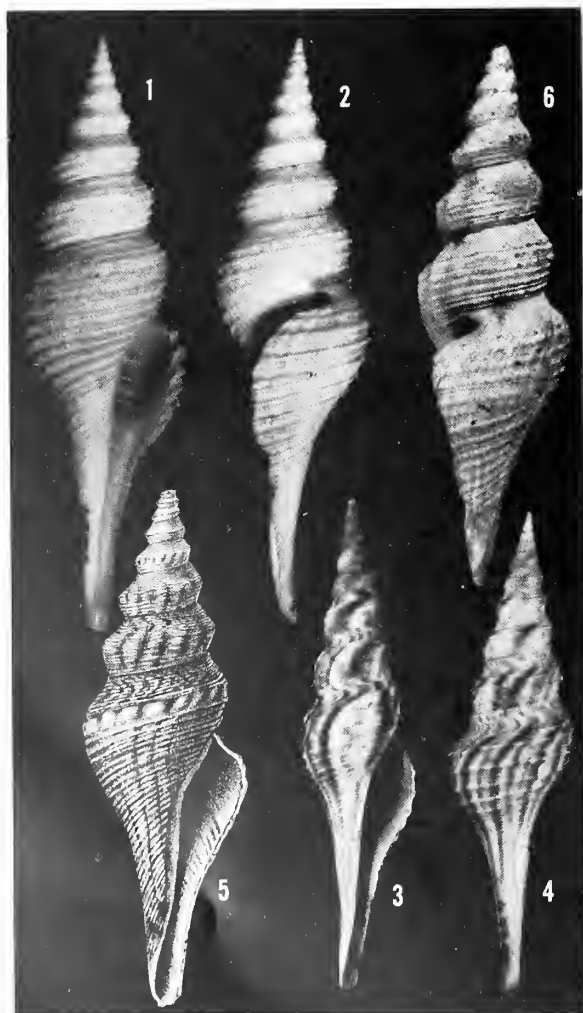


Plate 254. Figs. 1, 2, *Nihonia australis* (Roissy). Hong Kong. 97.5 mm. Figs. 3, 4, *Nihonia mirabilis* (Sowerby). Off Tosa, Japan. 73 and 71 mm. Figs. 5, 6, *Nihonia circumstricta* (von Martens). Off Dar-es-Salaam, East Africa, 404 metres (from von Martens, 1903, pl. 1, fig. 6) and off Pemba Island, 333 metres, East Africa, respectively. 51.0 and 63.0 mm., respectively.

**Nihonia mirabilis (Sowerby, 1914)**

(Pl. 192, pl. 15; Pl. 254, figs. 3, 4)

*Range*—Shelf waters of Japan.

*Description*—Shell large, 70-100 mm. (3-4 inches) in height, narrowly fusiform with tall spire, 28-30°, and long straight unnotched anterior canal. Spire about four fifths height of aperture plus canal. Whorls 11½, including a cylindrical protoconch consisting of 1½ smooth papillate whorls, the tip tilted and inrolled, followed by an almost straight-sided whorl, commencing with a few brephic axials, then smooth until it gradually resolves into the post-nuclear spiral sculpture (Pl. 253, figs. 1, 2). Adult sculpture of prominent but rather distant narrowly rounded smooth primary spiral cords and numerous interstitial spiral threads. Spire-whorls with a weak subsutural fold followed by a wide steeply descending lightly concave shoulder area to the uppermost cord at about two-thirds whorl height, followed by two or three somewhat stronger primary spiral cords, the lower one either immersed or emergent at the lower suture. The whorls are moderately convex and subangulate at most, at the second spiral cord. Body-whorl with about twelve primary spiral cords and 5-6 spiral threads in each interspace; neck and anterior canal with a similar arrangement of primary and secondary spirals, but much diminished in strength. The whole surface crowded with weak axial growth lines. Posterior sinus broad and rounded occupying the shoulder concavity from below the subsutural fold to the uppermost carina, horizontally projected below, far ahead of its point of origin above, and then confluent with the forwardly arcuately produced thin outer lip. Colour buff longitudinally obliquely streaked with reddish-brown.

*Measurements (mm.)—*

height	width	
101.0	25.0	Tomlin coll.
95.0	24.0	holotype
73.0	18.5	Tosa, Japan
72.0	19.0	Tosa, Japan
71.0	18.5	Tosa, Japan
64.5	16.5	Tosa, Japan

*Synonymy—*

- 1914 *Pleurotoma (Surcula) mirabilis* Sowerby, Ann. Mag. Nat. Hist., ser. 8, vol. 13, p. 445, pl. 18, fig. 1.  
 1934 *Orthosurcula mirabilis* (Sowerby), Hirase, A Collection of Japanese Shells, pl. 115, fig. 12.  
 1959 *Turricula (Orthosurcula) mirabilis* (Sowerby), Otuka, Venus, vol. 20, pt. 3, p. 245, fig. 2.  
*Records*—JAPAN: Nagasaki (type locality); Kochi, dredged (A. R. Cahn; ANSP); Tosa, dredged (Thaanum coll., Bishop Mus.).

**Nihonia australis (Roissy, 1805)**

(Pl. 192, figs. 16, 17; Pl. 254, figs. 1, 2)

*Range*—South China Sea.

*Remarks*—This is a well-known species, although it is not often seen in collections with accurate locality data. This is not *Murex australis* Gmelin, 1791, which is the common New Zealand struthiolarid, "*Pellicaria vermis* Martyn, 1786."

*Description*—Shell large, 75-100 mm. (3-4 inches) in height, elongate-fusiform with rounded whorls, a tall spire and a long straight unnotched anterior canal. Whorls encircled with rounded sharply raised spiral cords which are delicately beaded by a dense pattern of axial growth threads. Spire three fifths to four fifths height of aperture plus canal. Whorls 9½-10, plus a small smooth globular protoconch of 1½-2 whorls, with an asymmetric nucleus, followed by ¾ of a whorl of closely spaced brephic axials. Post-nuclear whorls sculptured firstly with two closely spaced subsutural spiral cords followed by a rather wide but shallowly concave shoulder area to a series of four primary spiral cords, the second of which from above forms a subangle at a little above middle whorl height. Primary spiral cords continue over the base but become weaker over the neck and anterior canal. From one to three or more subsidiary spiral threads in the interspaces and all spirals delicately beaded by a dense pattern of axial threads. Sinus deep and rather narrow, with its lower edge parallel to the suture and produced far forward, confluent with the swinging protractive arc of the thin outer lip. Operculum leaf-shaped with a terminal nucleus (Pl. 253, fig. 4). Colour pale orange-buff with the primary spirals orange-brown.

*Measurements (mm.)—*

height	width	
101.0	25.0	"Nagasaki, Japan" (Tomlin coll., Nat. Mus., Wales)
97.5	26.5	Hongkong (AWBP. coll., Auckland)
84.5	24.0	Hongkong (McAndrew coll., Brit. Mus.)
77.0	21.0	Hongkong (McAndrew coll., Brit. Mus.)

*Synonymy—*

- 1805 *Pleurotoma australis* Roissy, Hist. Nat. Moll. Anim. s. Vert. et sang. blanc. vol. 69, livraison 32, book 6, p. 72 (based upon Chemnitz, Conch. Cab. vol. 11, p. 111, pl. 190, figs. 1827, 1828; "La Mer du Sud").  
 1817 *Murex javanus* var. Dillwyn (non Linnaeus), Descr. Cat. Rec. Shells, vol. 2, p. 715.  
 1839-40 *Pleurotoma australis* Roissy, Kiener, Icon. Coq. Viv., Pleurotome, p. 6, pl. 4, fig. 1.  
 1843 *Pleurotoma australis* Roissy, Deshayes, Hist. Nat. Anim. sans Vert., 2nd. ed., vol. 9, p. 355.  
 1843 *Pleurotoma australis* Roissy, Reeve, Conchologia Iconica, vol. 1, pl. 2, fig. 14.

1846 *Pleurotoma turris* Valenciennes, Atlas Voy. Venus, pl. 5, f. 3. (non Lamarck, 1816).

1884 *Surcula australis* (Roissy), Tryon, Manual of Conch., vol. 6, p. 236, pl. 5, fig. 58

1904 *Orthosurcula australis* (Roissy) 'Lamarck', Casey, Trans. Acad. Sci. St. Louis, vol. 14, no. 5, p. 151.

1959 *Turricula* (*Orthosurcula*) *australis* (Roissy), Otuka, Venus, vol. 20, no. 3, p. 246.

*Records*—SOUTH CHINA SEA: i.e. "La Mer du Sud" (type locality); Hong Kong (ANSP; USNM; AWBP. coll.); 53 fms., mud. 20° 56' N; 114° 27' E, southeast of Hong Kong (A. J. Staple, ANSP). The Nagasaki record in the Tomlin collection is suspect since there seems to be no authentic Japanese record of this species in the literature.

### *Nihonia santosi* Shuto, 1969

(Pl. 254a)

*Range*—Panay Island, Philippines, upper part of Dingle Formation, Neogene.

*Remarks*—The species shows relationship with both the Japanese living *soyomaru*ae (Otuka), and the Pliocene *soyomaru*ae *takanabensis* (Otuka); from both it is distinguished by having a much stronger subsutural cord, a more deeply excavated shoulder, and wider primary spirals.

*Description*—Shell large, 69-78 mm. (about 3 inches) in height, very solid, narrowly fusiform, with rounded, slightly shouldered whorls, sculptured with strong smooth regular spiral ridges.

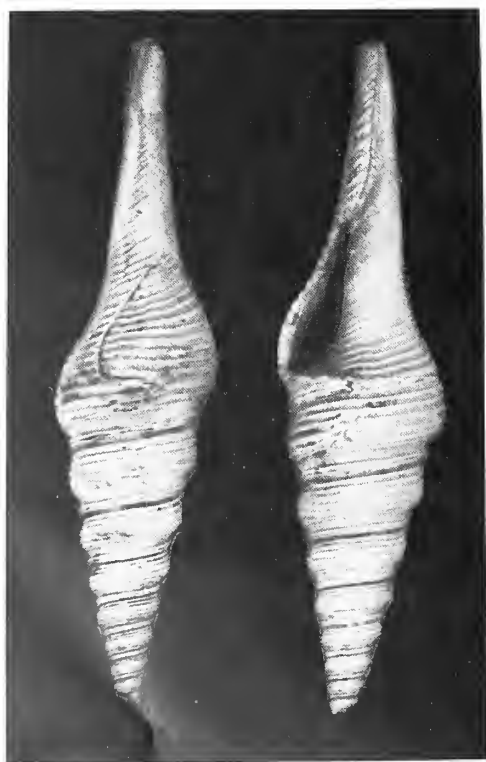


Plate 254a. *Nihonia santosi* Shuto, Panay Island, Philippines, Dingle Formation, Neogene. Paratype, 78+ mm. (from Shuto, 1969, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol., vol. 19, no. 1, pl. 19, figs. 18, 19.

### *Measurements* (mm.)—

height	width
78+	20.1+

### *Synonymy*—

1969 *Nihonia santosi* Shuto, Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., vol. 19, no. 1, p. 186, pl. 19, figs. 18, 19, 21; text fig. 34.

*Types*—The type material is in the Department of Geology, Kyushu University, Japan.

### *Nihonia soyomaru*ae (Otuka, 1959)

(Pl. 255, fig. 3)

*Range*—Japan (Recent), "Soyo Station 404".

*Remarks*—The description of this species is in Japanese, but the figure shows a shell closely similar to *australis* but of much more slender proportions, and the spiral cords do not appear to be beaded or decussated by the axial growth threads.

### *Measurements* (mm.)—

height	width
71.0	17.0

### *Synonymy*—

1959 *Turricula* (*Orthosurcula*) *soyomaru*ae Otuka, Venus, vol. 20, no. 3, p. 246, fig. 3.

### *Nihonia soyomaru*ae *subspecies* *takanabensis* (Otuka, 1959)

(Pl. 255, fig. 4)

*Range*—Takanabe, Pliocene of Japan.

*Remarks*—The description of this subspecies is confined to two lines in Japanese, but the figure shows a shell almost as slender as *soyomaru*ae but with more loosely coiled whorls and the shoulder area is more shallowly excavated. Again, the spiral cords appear to lack gemmules or crenulations.

### *Measurements* (mm.)—

height	width
66.0	19.0

### *Synonymy*—

1959 *Turricula* (*Orthosurcula*) *soyomaru*ae *takanabensis* Otuka, Venus, vol. 20, no. 3, p. 247, figs. 4, 5.

### *Nihonia shimajiriensis* MacNeil, 1960

(Pl. 255, fig. 1)

*Range*—Miocene of Okinawa.

*Description*—(original) "Shell of medium size and inflation. Protoconch consisting of 1½



smooth whorls, subnaticoidal and homeostrophous. Aperture long and of moderate width, about half as long as shell. Columella straight. Anal sinus situated about midway between the suture and the periphery, marked by broad U-shaped markings. Sculpture consisting of revolving lirations, one at the periphery being strongest with a slightly weaker one above, and a series of lirations below the periphery diminishing in strength towards the columella, interspaces with secondary, tertiary and sometimes quaternary lirations; subsutural slope bearing fine lirations above the anal fasciole and very faint lirations on the fasciole. Suture appressed. Whorls somewhat carinated in young, but becoming more rounded on the later whorls".

*Measurements (mm.)—*

height	width	
26 +	10.0	(holotype)

*Synonymy—*

1960 *Nihonia shimajiriensis* MacNeil, U.S. Geol. Surv. Prof. Paper, no. 339, p. 105, pl. 5, fig. 15.

*Types*—The holotype is in the United States National Museum, Washington.

*Records*—OKINAWA: (Yonabaru clay member, Miocene).

***Nihonia pervirgo* (Yokoyama, 1928)**

(Pl. 255, fig. 2)

*Range*—Pliocene of Japan.

*Remarks*—MacNeil (1960, p. 105) considered this species the only other known fossil referable to his *Nihonia*. He stated that it appears to have a microsculpture consisting of more irregular fine revolving lines, as well as somewhat broader primary lirations.

MacNeil (1960, p. 105) referred to a Recent specimen of this genus in the Hirase collection, U. S. National Museum, which is labelled *Orthosurcula mirabilis* (Sowerby), but does not appear to be Sowerby's species. However, I was not able to locate this shell.

*Measurements (mm.)—*

height	width
35+	—

*Synonymy—*

1928 *Pleurotoma pervirgo* Yokoyama, Tokyo Imper. Univ. Faculty Sci. Journ. sec. 2, vol. 2, no. 7, p. 340, pl. 66, fig. 8.

1952 *Orthosurcula mirabilis pervirgo* (Yokoyama), Hatai & Nisiyama, Saito Ho-on Kai Mus. Res. Bull., no. 19, p. 232.

1959 *Turricula (Orthosurcula) pervirgo* (Yokoyama), Otuka, Venus, vol. 20, no. 3, p. 247, figs. 6, 7.

1960 *Nihonia pervirgo* (Yokoyama), MacNeil, U. S. Geol. Surv. Prof. Paper, no. 339, p. 105.

*Records*—JAPAN (Kounji formation, Pliocene).

***Nihonia sucabumiana* (K. Martin, 1895)**

(Pl. 255, figs. 5, 6)

*Range*—Miocene of Java and Pliocene of Sumatra.

*Remarks*—The author of this species compared it with the Recent *australis*, which it appears to resemble in the swollen rounded whorls. However, the spire in the Java fossil is more squat and the sculpture is of spiral rows of gemmules rather than of spiral cords decussated by dense axial growth lines.

*Synonymy—*

1895 *Pleurotoma (Surcula) sucabumiana* K. Martin, Die Foss. von Java, vol. 1, Gast. Samml. Geol. Reichs-Mus., Leiden, p. 30, pl. 5, fig. 75.

1919 *Surcula sucabumiana* (Martin), K. Martin, Palaeozool. Kenntnis von Java, p. 74.

1931 *Surcula sucabumiana* (Martin), Vlerk, Leidsche Geol. Meded., vol. 5, p. 220.

*Records*—JAVA: Tji, Talahap, Sukabumi (Rembang and Njalindoengbeds, lower Miocene) (type locality). SUMATRA: (Pliocene) (van der Vlerk, 1931).

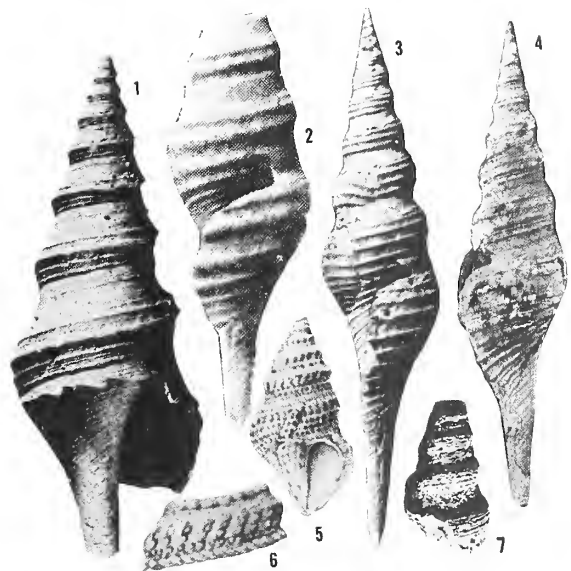


Plate 255. Fig. 1, *Nihonia shimajiriensis* MacNeil. Miocene of Okinawa. 26 mm. (from MacNeil, 1960, pl. 5, fig. 15). Fig. 2, *Nihonia pervirgo* (Yokoyama). Pliocene of Japan. 34.5 mm. (from Otuka, 1959, p. 248, fig. 7). Fig. 3, *Nihonia soyomaru* (Otuka). Japan, Recent. 71.0 mm. (from Otuka, 1959, p. 248, fig. 3). Fig. 4, *Nihonia soyomaru takanabensis* (Otuka). Pliocene of Takanabe, Japan. 66.0 mm. (from Shuto, 1961, pl. 4, fig. 8). Figs. 5, 6, *Nihonia sucabumiana* (K. Martin). Miocene of Java (from K. Martin, 1895, pl. 5, fig. 75). Fig. 7, *Nihonia birmanica* (Vredenburg). Miocene of Burma. 18 mm. (from Vredenburg, 1921, pl. 12, fig. 4).

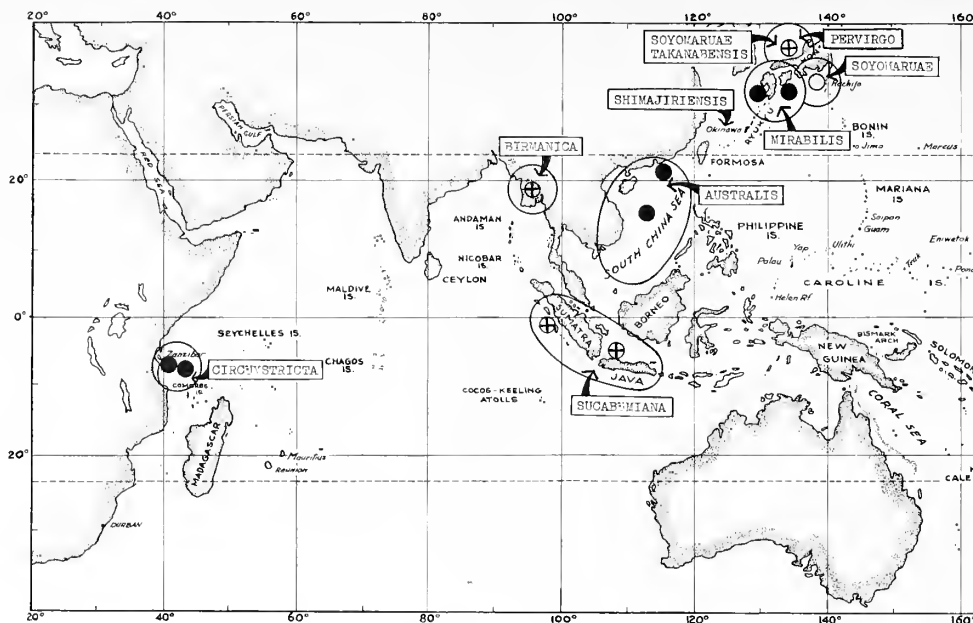


Plate 256. Geographical distribution of the Recent *Nihonia australis* (Roissy), *N. circumstricta* (von Martens), *N. mirabilis* (Sowerby), *N. soyomaruae* (Otuka) and the Tertiary *N. birmanica* (Vredenburg), *N. soyomaruae takanabensis* (Otuka), *N. shimajiriensis* MacNeil and *N. sucabumiana*

### ? *Nihonia birmanica* (Vredenburg, 1921)

(Pl. 255, fig. 7)

*Remarks*—This species is known to me only from the original illustration of the badly preserved very incomplete holotype. The author compared his species with *Surcula sismondiae* (Bellardi & Michelotti, 1841) from the Tortonian Miocene of Piedmont, Italy. Vredenburg's illustration shows a shell with rounded strongly spirally corded whorls and lacking in axial sculpture.

The species probably belongs to *Nihonia*.

#### *Synonymy*—

1921 *Surcula birmanica* Vredenburg, Rec. Geol. Surv. India, vol. 53, no. 2, p. 90, pl. 12, fig. 4.

*Records*—BURMA: Tetna (Sitsayan stage, Stampian, Oligocene).

### *Nihonia circumstricta* (von Martens, 1901)

(Pl. 254, figs. 5, 6)

*Range*—Off East Africa, 300-400 metres.

*Description*—Shell moderately large, 50-65 mm. (2-2½ inches) in height, elongate-fusiform with angulate to rounded whorls. Sculpture of strong crisp spiral cords, overriding oblique axial folds, which are distinct on the spire-whorls but subobsolete over the last whorl. Spire slightly less than height of aperture plus canal; angle 31-32°. Whorls 8-9 +, protoconch missing in all

available specimens. Spire-whorls weakly angulate at or a little above middle whorl height. Shoulder wide, straight and steeply descending, without a definite subsutural margining but the whole area crossed by 6 or 7 fine crisp spiral threads. From the peripheral angle to the lower suture there are from 4 to 6 strong spiral cords with a thread in each interspace. On the body-whorl the cords continue over the base and neck but become weaker and linear spaced towards the end of the anterior canal. Axial folds short, protractively oblique, restricted to the vicinity of the periphery and becoming subobsolete to obsolete over the body-whorl. All of the spirals are decussated by dense axial growth lines. Sinus moderately deep but accentuated by the forwardly produced outer lip. Colour "nodulis albis, interstitiis et fascia ventrali fulvis" (Martens). The "John Murray Expedition" specimens are bleached dead shells. Martens (1903) described and figured the operculum of the holotype, as leaf-shaped, with a terminal nucleus.

#### *Measurements* (mm.)—

height	width	
63 +	19.0	Off Pemba Island
51.0	15.5	holotype

#### *Synonymy*—

1901 *Pleurotoma circumstricta* von Martens, Sitz. d. Ges. nat. Freunde, Berlin, p. 15.

1903 *Pleurotoma (Surcula) circumstricta* von Martens, von Martens & Thiele, Gast. deutsch. Tiefsee Exped, 1898-1899, p. 79, pl. 1, f. 6.

*Records*—EAST AFRICA: off Dar-es-Salaam, 6° 34'S., 39 35'E., 404 metres (type locality); off Pemba Island, 5° 03' 42"S., 39° 15' 24"E., 333 metres (John Murray Exped., Sta. 110, Brit. Mus. Nat. Hist.).

## Genus *Leucosyrinx* Dall, 1889

**Type:** *Pleurotoma verrilli* Dall, 1881

The genus *Leucosyrinx* has an almost cosmopolitan distribution mainly in the ocean deeps. Fossil occurrences are known definitely from the Miocene of Central America, the Miocene-Pliocene of Okinawa and no doubt will later be recognised from a wider range of Tertiary localities.

The shell is usually of light build, elongate-fusiform, with a tall spire and a moderately long straight or lightly flexed unnotched anterior canal. The anal sinus is moderately deep and occupies the whole of the shoulder slope, its apex being broadly shallowly concave.

There is no subsutural margining fold, so the sinus commences at the upper suture. Below, the sinus is confluent with a considerable forward arcuate projection of the outer lip, which accentuates the appearance of depth to the sinus.

The sculpture usually consists of axial nodes on the peripheral angle and plain spiral cords or threads on the lower part of the whorls. The protoconch is small, globular of 1½-2 smooth whorls and the operculum is thin, ovate to leaf-shaped, with a terminal nucleus, the scar of attachment usually small. Most species are devoid of colour pattern, and have a thin buff or pale olivaceous periostracum.

The dentition of *Leucosyrinx* presents a problem since that of the type species, *verrilli* Dall (from manuscript drawings in the United States National Museum, prepared by Dr. J. P. E. Morrison), show a radula consisting of marginals only, which are of modified "wish-bone"-type; i.e., of two elongated teeth, the larger superimposed upon a smaller and narrower member (Pl. 191, fig. 11).

On the other hand the radula figured by Thiele (1903, Wiss. Ergeb. deutsch. Tiefsee-Exped., vol. 7, pl. 9, f. 73) for the misidentified "*Brachytoma griffithi* (Gray)" of Martens (1903, l.c., p.

84), which was later named *Leucosyrinx sansibarica* by Thiele (1925, Wiss. Ergeb. deutsch. Tiefsee-Exped., vol. 17, 2, p. 215, pl. 24, fig. 1), consists not only of marginals but also has a large-based unicuspid central tooth. However it is not certain that the radula figured by Thiele, 1903, was from the actual specimen he later named *sansibarica*, which is certainly a *Leucosyrinx*.

This is the style of radula found in both *Cochlespira* (= *Ancistrosyrinx*) and in *Aforia*, but on the other hand, *Irenosyrinx persimilis* Dall, from 677 fathoms off Chile, a shell indistinguishable from *Aforia*, has the central tooth reduced to a tiny vestigial plate without a cusp.

Again, the radula figured by Thiele (1929, Handb. Syst. Weicht., p. 358, fig. 435) for Martens' *Leucosyrinx crispulata* has a large unicuspid central, but the species appears to be a *Cochlespira*, i.e., *Cochlespirinae*.

It would appear from the above that little significance can be adduced from the presence or absence of a central tooth in the radula of this group of genera, in which case there is not much ground for the retention of the subfamily *Cochlespirinae*, as distinct from the subfamily *Turriculinae*.

The type species and a number of others are from the deep water basins of the Southern United States and the Caribbean.

The genus occurs also in the deep waters of the Eastern Pacific, the Indo-Pacific, the South Atlantic and Antarctica.

In the list of characteristic species that follows, many names of both Recent and Tertiary nominate species are omitted since there has not been opportunity for examining the sinus, which is the main diagnostic feature for the genus. Among Dall's 1919 Recent West American-Panamic species attributed to *Leucosyrinx*, *galapagana* and *amycus* are definitely not of that genus.

**Characteristic species**—(apart from those dealt with in this number). Recent, Caribbean:—*sigsbeeii* (Dall, 1881), *subgrundifera* (Dall, 1888), *tenoceras* Dall, 1889, *verrilli* (Dall, 1881). Recent, Subantarctic and Antarctic:—*falklandica* Powell, 1951, *macrobertsoni* Powell, 1958, *mawsoni* Powell, 1958, *paragenota* Powell, 1951 and *paratenoceras* Powell, 1951.

### *Synonymy*—

1889 *Leucosyrinx* Dall, "Blake" report, Bull. Mus. Comp. Zool., vol. 18, no. 29, pt. 2, p. 75. Type by original designation: *Pleurotoma verrilli* Dall, 1881.



### Key to species of *Leucosyrinx*

- Carina medially situated . . . . . subgenus *Leucosyrinx* (*s. str.*)
  - Shell large (35-73 mm.)
    - Axials persistent throughout
      - Colour pattern of brown flames
        - Shell narrow
          - Axials numerous small nodes
            - ..... *queenslandica* Powell, *n. sp.*
      - Colour orange-brown, carina darker
        - Axials obsolete, except on early whorls
          - ..... *pikei* (Dell)
    - Colour pattern absent
      - Shell relatively wide
        - Axials large oblique nodes
          - Base with strong angulation . . . . . *julia* Thiele
          - Base with weak angulation . . *sansibarica* Thiele
        - Axials long and oblique on spire, subobsolete on body-whorl
          - Spiral sculpture densely lirate
            - ..... *iwaensis* MacNeil
  - Shell small (5.75-8 mm.) (probably immature)
    - Axials paired elongated horizontal nodes
      - Basal cords, one, smooth . . . . . *caecilia* Thiele
    - Axials oblique peripheral nodes
      - Basal cords, three, smooth . . . . . *erna* Thiele
    - Axials, 2-3 rows of strong rectangular nodes *elsa* Thiele
- Carina at lower suture . . . . . subgenus *Sibogasyrinx*
  - Spire height less than aperture plus canal
    - Spiral lirations absent from shoulder slope
      - ..... *pyramidalis* (Schepman)
  - Spire height greater than aperture plus canal
    - Spiral lirations over whole shell
      - ..... *archibenthalis* Powell *n. sp.*

**Leucosyrinx caecilia Thiele, 1925**

(Pl. 257, fig. 2)

*Range*—Off Dar-es-Salaam, East Africa, 6° 34.8'S., 39° 35.5'E., 404 metres.

*Remarks*—This species is based upon a juvenile of only 7 mm. × 3 mm., consisting of the protoconch and two succeeding whorls only. It should not have been described for it is impossible to visualise the adult form of the shell with accuracy. It resembles *julia* Thiele, 1925, in the presence of a smooth spiral ridge on the upper part of the base but this is situated higher than in that species. Its most distinctive feature is in the form of the peripheral nodes, which are vertically paired undulations on two linear spaced strong spiral cords, set on a low-sited acute angulation.

*Synonymy*—

1925 *Leucosyrinx caecilia* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped., vol. 17, Gastr. 2, p. 236, pl. 24, fig. 23.

*Types*—The holotype is in the Zoological Museum, East Berlin.

**Leucosyrinx elsa Thiele, 1925**

(Pl. 257, fig. 3)

*Range*—Zanzibar Channel, 463 metres and off Dar-es-Salaam, 404 metres.

*Remarks*—This species again is based upon an immature shell of only 5.75 mm. × 2.5 mm., consisting of a smooth globular protoconch of 1½ whorls and four post-nuclear whorls. The whorls are strongly angulate medially, and the sculpture is of spiral rows of rectangular nodes, in two linear spaced series on the spire, with a third emergent on the base. Immediately following the nodular spirals are five linear spaced plain spirals extending over the neck.

*Synonymy*—

1925 *Leucosyrinx elsa* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped., vol. 17, Gastr. 2, p. 235, pl. 24, fig. 21.

*Types*—The holotype is in the Zoological Museum, East Berlin.

**Leucosyrinx erna Thiele, 1925**

(Pl. 257, fig. 1)

*Range*—Zanzibar Channel, East Africa, 5° 27.9'S., 39° 18.8'E., 463 metres.

*Remarks*—This species also is based upon an

immature shell of only 8 mm. × 3 mm., consisting of a smooth globular protoconch of 1½ whorls and five post-nuclear whorls. It is rather similar to *julia* Thiele, 1925, but has much stronger spiral sculpture composed of four linear spaced smooth cords from below the peripheral nodes to the basal subangle, after which there is a smooth area, followed by three linear spaced weaker spirals on the neck.

*Synonymy*—

1925 *Leucosyrinx erna* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped., vol. 17, Gastr. 2, p. 235, pl. 24, fig. 22.

*Types*—The holotype is in the Zoological Museum, East Berlin.

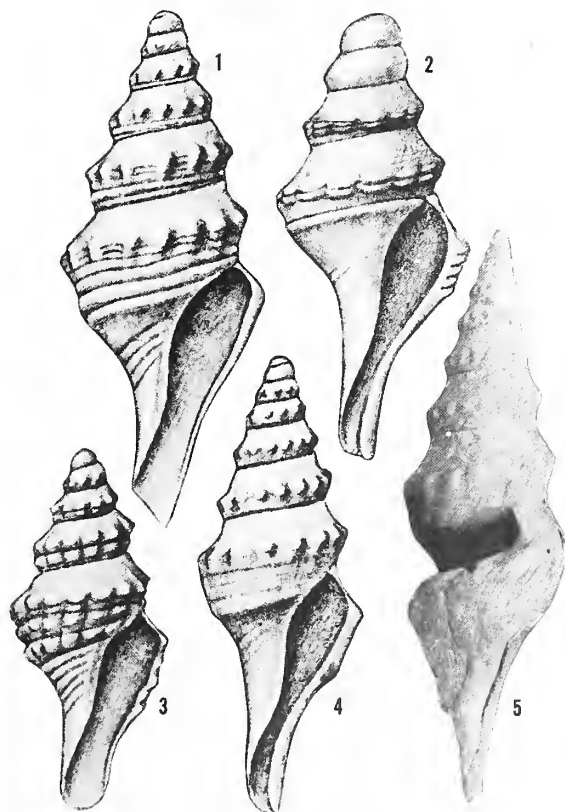


Plate 257. Fig. 1, *Leucosyrinx erna* Thiele. Zanzibar Channel, 463 metres. 8.0 mm. Fig. 2, *Leucosyrinx caecilia* Thiele. Off Dar-es-Salaam, East Africa, 404 metres. 7.0 mm. Fig. 3, *Leucosyrinx elsa* Thiele. Zanzibar Channel, 404 metres. 8.0 mm. Figs. 4, 5, *Leucosyrinx julia* Thiele. Off Kenya, East Africa, 693 metres. 10.5 mm, and Gulf of Aden, 1040 metres. (figs. 1-4 from Thiele, 1925, pl. 24, figs. 21-24).

***Leucosyrinx julia* Thiele, 1925**

(Pl. 257, figs. 4, 5)

*Range*—Off East Africa to the Gulf of Aden, 693 to 1040 metres.

*Remarks*—The John Murray Expedition shells from the Gulf of Aden in 1040 metres seem to represent the adult of Thiele's *julia*, which was described from an immature shell of 10.5 mm. from 693 metres off East Africa. The basal angulation, which is strongly present in Thiele's type, is subobsolete in the specimen I take to represent the adult of this species, but one would expect such a feature to be more pronounced in the juvenile, for there is often an obsolescence of sculptural features over the last whorl in adult shells of comparable species.

*Description* (Based upon a John Murray Expedition adult)—Shell moderately large, 53 mm. (2 $\frac{1}{8}$  inches) in height, elongate-fusiform, with tall turreted spire and relatively long straight unnotched anterior canal. Spire equal in height to that of aperture plus canal. Protoconch missing. Post-nuclear whorls sharply angulate at about lower third of whorl height. Shoulder area wide, almost straight and steeply descending. Axial sculpture restricted to the peripheral angle and consisting of oblique nodes, which are longer than wide, 19-20 per whorl. The only other axial sculpture is in the form of weak irregular growth lines, a little stronger at rest stages, where they define the sinus curves on the otherwise smooth shoulder slope. The spiral sculpture is of irregular closely spaced weak cords which commence between the peripheral nodes and continue over the base to the anterior end. Several of these cords are somewhat stronger on a weak basal subangle. Sinus broad, with a slightly concave apex, occupying the whole of the shoulder slope, and confluent below with a great forward swing of the outer lip, which gives the impression of a sinus of great depth. Colour opaque-white with traces of a thin yellowish-buff epidermis.

*Measurements (mm.)—*

height	width	
10.5	3.6	holotype
53.0+	17.0	Gulf of Aden, 1040 metres.

*Synonymy—*

1925 *Leucosyrinx julia* Thiele, Wissenschaft Ergebn. Deutschen Tiefsee-Exped., vol. 17, Gastr. 2, p. 236, pl. 24, fig. 24.

*Types*—The holotype is in the Zoological Museum, East Berlin.

*Records*—EAST AFRICA: 1° 40.6'S., 41° 47.1'E., 693 metres (type). GULF OF ADEN: 13° 05' 36"N., 46° 24' 42"E., 1040 metres (John Murray Exped. Sta. 34; Brit. Mus.).

***Leucosyrinx queenslandica*  
*new species* Powell**

(Pl. 258, figs. 1, 2)

*Range*—South Queensland in 70-100 fathoms.

*Remarks*—This species differs from other members of the genus in having a definite colour pattern. It appears to be nearest allied to *julia* Thiele but has more prominent and rounded, rather than narrowly oblique, peripheral nodes. Also the spire angle is less, the shoulder slope

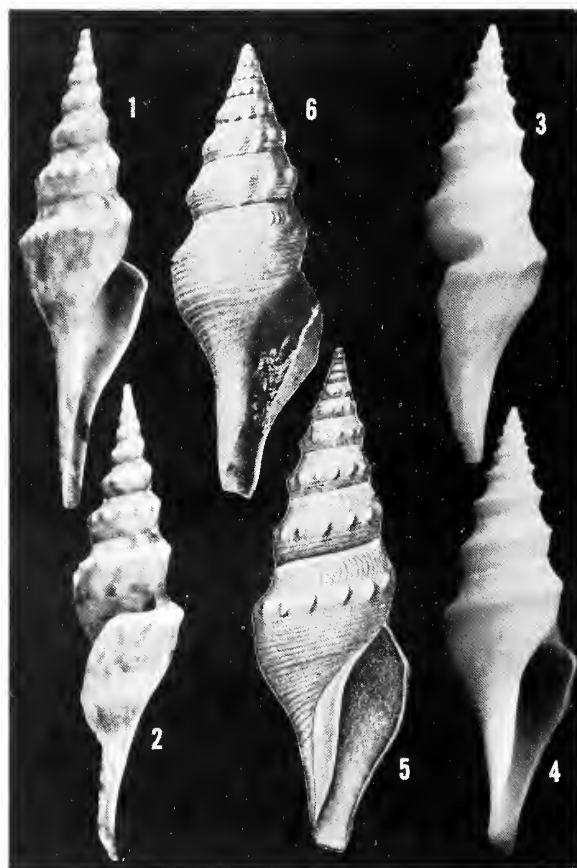


Plate 258. Figs. 1, 2, *Leucosyrinx queenslandica* Powell, new species. Holotype, South Queensland, 12-15 miles off Cape Moreton, 70-100 fathoms. 56.5 mm. Figs. 3, 4, *Leucosyrinx pikei* (Dell). Holotype, New Zealand, off Poor Knights Islands, 256-267 fathoms. 35 mm. Fig. 5, *Leucosyrinx sansibarica* Thiele. Pemba Channel, Zanzibar, 818 metres (from Thiele, 1925, pl. 24, fig. 1). Fig. 6, *Leucosyrinx iwaensis* MacNeil. Okinawa, Miocene or Pliocene. 25.0 mm. (from MacNeil, 1960, pl. 9, fig. 24).



more concave. The sinus occupies only the upper half of the shoulder slope, and that area is finely lirate, not smooth. Also the spiral sculpture of the body-whorl, below the angle, is irregularly in the form of distant cords with several threads in each interspace.

*Description*—Shell moderately large, 56-57 mm. (2¼ inches) in height, narrowly fusiform, with tall turreted spire, about five sixths height of the aperture plus the canal, which is long and almost straight, with an unnotched termination. Protoconch small, of 1½-2 smooth whorls, first bulbous and asymmetric, next rather flat-sided. Post-nuclear whorls strongly angulate just below middle whorl height. Axial sculpture of strong rounded peripheral nodes, about 16 per whorl. Spiral sculpture consisting of about seven fine threads over the upper shoulder slope, or sinus area, followed by closely spaced cords and threads of varying strength. The spiral threads weakly override the peripheral axials and continue below over the body-whorl to the anterior end, developing to subcord strength at irregular intervals. Sinus of moderate depth, with a broad shallowly concave apex, the whole occupying the upper two-thirds of the shoulder slope. The lower edge of the sinus is confluent with a great forward arcuate projection of the thin outer lip. Colour buff, densely diffused-maculated with reddish-brown. The more definite maculations are rectangular patches in the interspaces of the peripheral nodes, and two series of large rectangular blotches, one just above the lower suture, the other encircling the neck.

*Measurements (mm.)—*

height	width	
56.5	15.5	holotype
57.0	15.25	paratype

*Types*—The holotype, presented by Mr. T. Garrard, is in the Australian Museum, Sydney.

*Records*—SOUTH QUEENSLAND: 12-15 miles N. N. E. of Cape Moreton, 70-100 fathoms (Mr. T. Garrard) (holotype); off Caloundra, 70 fathoms (Mr. O. H. Rippingale).

**Leucosyrinx pikei (Dell, 1963)**

(Pl. 258, figs. 3, 4)

*Range*—New Zealand, off north east coast, 256-267 fathoms.

*Remarks*—This species is narrowly-fusiform, medium sized, and is characterised by the form of the peripheral carina, which is nodulose only over the first six post-nuclear whorls, after which it is a bluntly rounded fold. The coloration is whitish on the early spire whorls, grading to light

orange-brown below, the peripheral cord darker.

There is a superficial resemblance to the Japanese *lurida* auct. (non Adams & Reeve, 1850) = *kirai* n. sp., but that species has a *Comitas*-style sinus, more deeply and narrowly rounded at its apex, which is just above the middle of the shoulder slope.

The genus *Waitara* to which this species was originally assigned is now considered to be closely allied to, if not identical with *Thatcheria*, a large Japanese shell with a *Daphnellid* style sinus and a reticulated sinusigerid protoconch.

*Description*—Shell of medium size, 34-35 mm. (1⅜ inches) in height, narrowly fusiform, of light build, with tall spire and long straight unnotched anterior canal. Whorls 9½, including the protoconch which is of 1½ rather flattened globose whorls, seemingly smooth and glossy, but under magnification there is a weak sculpture of retro-current axials crossed by finer incised spirals. Spire slightly less in height than that of the aperture plus the canal. Whorls strongly angled below the middle on the early whorls and about the middle over the later whorls. Shoulder area broad, weakly concave and steeply descending. First six whorls of the teleoconch sculptured with thread-like axials, which resolve into strong nodules at the peripheral carina. The axial sculpture becomes subobsolete over the antepenultimate and completely so over the remaining whorls. Spiral sculpture well developed; shoulder slope with about ten threads, uppermost 3 or 4 rather stronger; peripheral angulation with 3-5 strong closely-spaced spirals; lower part of the spire whorls with from 3-10 moderately strong threads; body-whorl, base and canal crowded with linear-spaced evenly developed moderately strong threads. Sinus broad and shallowly arcuate, occupying the whole of the shoulder slope, its lower margin confluent with a considerable forward swing of the thin outer lip. Colour as described above.

*Measurements (mm.)—*

height	width	
35.0	10.8	holotype
34.0	10.0	paratype

*Synonymy*—

1963 *Waitara pikei* Dell, Trans. Roy. Soc. N. Z., Zool., vol. 3, no. 20, p. 215, text figs. 3, 4.

*Types*—The holotype and paratype are in the Dominion Museum, Wellington, New Zealand.

*Records*—NEW ZEALAND: 18 mi. N, 30° E. of Poor Knights Islands, 256-267 fathoms (holotype); 17 mi. N. E. of Cavalli Islands, 260 fathoms (paratype).

***Leucosyrinx sansibarica* Thiele, 1925**

(Pl. 258, fig. 5)

*Range*—Pemba Channel, Zanzibar, 818 metres (type) and Gulf of Aden, 1469 metres.

*Remarks*—Thiele proposed this as a new name for an East African deep water species misidentified by Martens, 1903, as *Brachytoma griffithi* (Gray). At the same time Martens described a var. *gracilis* from the Pemba Channel, Zanzibar in 818 metres, but Thiele (1925, l.c.) recommended the ignoring of this varietal name since the specimen was not figured nor can it now be located.

Thiele's *sansibarica* is well figured but not described in detail, nor are measurements cited, but the figure, which shows an adult shell, is evidently natural size, indicating a height of 73.5 mm. and a width of 24 mm.

*Description* (from figure)—Shell large, 73.5 mm. (27/8 inches) in height, narrowly fusiform with a tall spire, greater than height of aperture plus canal. The spire whorls are angulate below the middle and the shoulder area is wide, only slightly concave, and steeply descending. The body-whorl is narrow and slowly contracted to a moderately long unnotched rather straight canal. Sculpture of rather distant ovate axial nodes on the peripheral angle, about 10-11 per whorl, and dense distinct linear spaced smooth spiral cords from below the periphery. The shoulder area is devoid of spirals but exhibits closely spaced axial growth lines, indicating a moderately deep broadly arcuate sinus, the apex of which occupies most of the shoulder slope.

***Synonymy*—**

- 1903 *Brachytoma griffithi* von Martens (not of Gray in Griffith & Pidgeon, 1834), Wissenschaft Ergeb. deutsch. Tiefsee-Exped., vol. 7, p. 84.  
 1903 *Brachytoma griffithi*, Thiele (not of Gray in Griffith & Pidgeon, 1834), Wissenschaft Ergeb. deutsch. Tiefsee-Exped., vol. 7, p. 173, pl. 9, f. 73 (radula). This radula, attributed to *Brachytoma griffithi* of Thiele, 1903 (non Gray), shows a large-based unicuspid central and stout bifid-based marginals. However no significance can be attached to this figure owing to uncertainty regarding the actual shell from which the radula was obtained.  
 1925 *Leucosyrinx sansibarica* Thiele, Wissenschaft Ergeb. deutsch. Tiefsee-Exped., vol. 17, Gast. 2, p. 215, pl. 24, fig. 1.

***Leucosyrinx iwaensis* MacNeil, 1960**

(Pl. 258, fig. 6)

*Range*—Miocene or Pliocene, Shinzato tuff member, Okinawa.

*Remarks*—This species shows some resem-

blance to the Recent East African *sansibarica* Thiele, 1925, both in shape and in the dense pattern of spiral cords, from the peripheral angle downwards. The chief differences are in the axial folds extending downward, buttressing the peripheral tubercles and a more deeply excavated base over the region of the neck.

*Description*—Shell of moderate size, 25 mm. (1 inch) in height, elongate-fusiform. Spire tall, equal in height to that of the aperture plus the canal. Whorls medially rather sharply angulate, with a steep almost straight shoulder slope. Protoconch small of 1½ smooth whorls. Axials oblique, fold-like, tuberculate at the peripheral angle, but almost obsolete at the lower suture; entirely obsolete over the last three quarters of a whorl. Closely spaced spiral cords over the entire surface from below the periphery. Sinus broad and deep, only slightly concave at the apex and occupying most of the shoulder slope. Outer lip thin and strongly forwardly arcuately projecting.

***Measurements* (mm.)—**

height	width
25.0	8.3

***Synonymy*—**

1960 *Leucosyrinx iwaensis* MacNeil, U.S. Geol. Survey Prof. Paper, no. 339, p. 109, pl. 9, fig. 24.

*Types*—The holotype is in the United States National Museum.

**? *Leucosyrinx suratensis* (Thiele, 1925)**

(Pl. 259, figs. 1, 2)

*Range*—South west of Surat Passage, Sumatra in 1024 metres.

*Remarks*—This species is known to me only from von Martens' figure, which is a side view of the shell showing the sinus. If this sinus is natural and not the result of damage to the outer lip, then the species is a *Leucosyrinx*. Also the anterior canal appears to be broken at its extremity and if this is so a relatively long and straight anterior canal is indicated, again a characteristic of *Leucosyrinx*. Von Martens' reference of this shell to *coreanica* (Adams & Reeve) implies the genus *Makiyamaia* but in that genus the sinus is shallowly U-shaped, at or a little below the middle of the shoulder slope, the peripheral angle is low down on the spire whorls, and the anterior canal is relatively short.

If this species is a *Leucosyrinx* then it differs from the other Indo-Pacific species in the dense crisp spiral lirae which appear to be particularly strong over the base.

- Synonymy*—
- 1903 *Surcula coreanica* (Adams & Reeve) (not of Adams & Reeve, 1850), von Martens, Gast. deutsch. Tiefsee-Exped., vol. 7, p. 80, pl. 2, fig. 3.
- 1925 *Surcula suratensis* Thiele, Gast. deutsch. Tiefsee-Exped., vol. 17, pt. 2, p. 214, pl. 23, fig. 19; detail of spire-whorls in comparison with those of *coreanica*, pl. 23, fig. 20) (nom. nov. for *S. coreanica* von Martens, 1903; non Adams & Reeve, 1850).



Plate 259. Fig. 1, *Leucosyrinx suratensis* (Thiele). S. W. of Surat Passage, Sumatra, 1024 metres. 17.0 mm. (from von Martens, 1903, pl. 2, fig. 3, as *coreanica*, non Adams & Reeve, 1850). Fig. 2, *Leucosyrinx suratensis* (Thiele) (from Thiele, 1925, pl. 23, fig. 20).

*Leucosyrinx crispulata* (von Martens, 1901)  
(Pls. 261 and 262)

*Range*—Off East Africa, deep water.

*Remarks*—This is another problematic species, of which the writer has not seen material. From the published description and figure, the species could be accommodated almost equally well in *Leucosyrinx*, *Cochlespira* or *Aforia*. Von Martens' comparison of his species with both the Kerguelen Island *Pleurotoma staminea* Watson and the Patagonian *Pleurotoma clara* von Martens, points to *Aforia*, and the style of radula is not inconsistent either, but the "carina minutissime nodulosa" is a feature foreign to *Aforia*. In *Cochlespira* the carina, certainly, is nodulose to spinose, but in that genus the anterior canal is straight or almost so, not twisted as shown in the original illustration of *crispulata*. Except for the radula, with its enlarged unicuspid central tooth, very like that of *Aforia*, the conclusion is that the sum of characters point to the original generic location of *Leucosyrinx*.

Too much significance cannot be placed upon the enlarged central tooth, for that member has been shown to fluctuate from fully developed to vestigial with a compact genus, such as *Aforia*, and similarly in random species of Turridae, Turriculinae and Clavatulinae, a large central tooth may be present in some species, vestigial or absent in others.

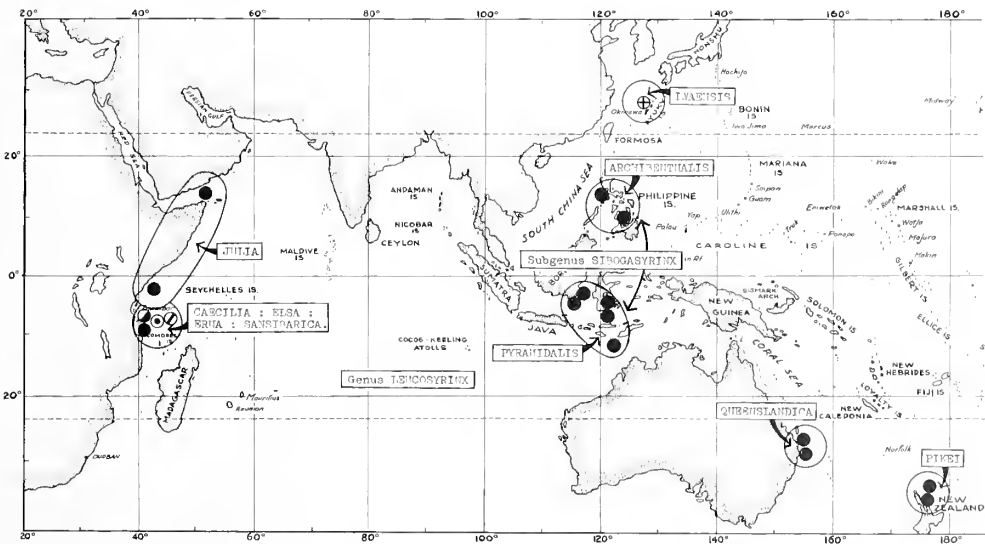


Plate 260. Geographical distribution of the Recent *Leucosyrinx caecilia*, *elsa*, *erma* and *julia* of Thiele, *piki* (Dell), *queenslandica* Powell, new species, *sansibarica* Thiele and the Tertiary *ivaensis* MacNeil. Also the Recent *Sibogasyrinx* (new subgenus) *archibenthalis* Powell, new species and *L. (S.) pyramidalis* (Schepman).



Notable features of *crispulata*, according to the figure, are the sharp, narrow, finely nodulose peripheral carina, divaricate spiral sculpture on the body-whorl, lirate interior of the outer lip, and long decidedly twisted anterior canal.

Von Martens and Thiele nominated a variety *denticulosa* of the typical species, *crispulata*, said to differ in that the carina has about twenty short denticulations, whereas that of the typical species is minutely nodulose. This variety was not figured, nor was it adequately described. The measurements given, 15.5 mm.  $\times$  5.0 mm., in-

dicates an immature example, and so until a type specimen can be located, if such exists, the variety is better included in the synonymy of the typical species.

*Measurements (mm.)—*

height	width
37.0	9.0

*Synonymy—*

1901 *Pleurotoma (Leucosyrinx) crispulata* von Martens, Sitzungsberichte d. Gesellsch. nat. Freunde Berlin, p. 16.

1903 *Leucosyrinx crispulata* (von Martens), von Martens and Thiele, Wiss. Ergeb. deutsch. Tiefsee Exped., vol. 7, p. 89, pl. 1, fig. 5.

1903 *Leucosyrinx crispulata* var. *denticulosa* von Martens and Thiele, Wiss. Ergeb. deutsch. Tiefsee Exped., vol. 7, p. 90.

*Records—EAST AFRICA:* off Dar-es-Salaam, 400 metres (type) and 404 metres.

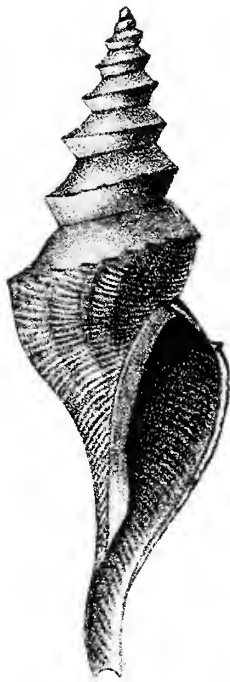


Plate 261. *Leucosyrinx crispulata* (von Martens). 404 metres off Dar-es-Salaam, East Africa. 37 mm. Holotype (from von Martens and Thiele, 1903, Wiss. Ergeb. deutsch. Tiefsee Exped., 7, pl. 1, fig. 5).

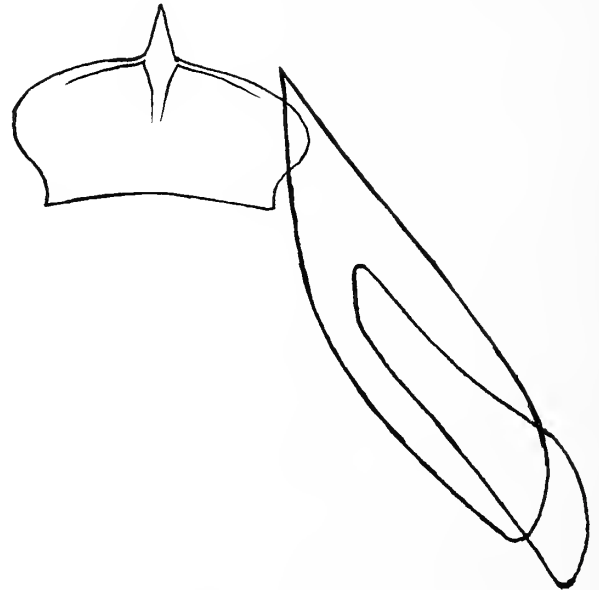


Plate 262. *Leucosyrinx crispulata* (von Martens). Radula (from Thiele, 1929, Handb. Syst. Weicht., p. 359, fig. 435).

### Subgenus *Sibogasyrinx* Powell new subgenus

Type: *Surcula pyramidalis* Schepman, 1913

#### *Leucosyrinx pyramidalis* (Schepman, 1913)

(Pl. 264, figs. 1-5)

**Range**—Off Celebes, Borneo and Timor Sea, 260 to 484 fathoms.

**Remarks**—This species, a probable subspecies of it and a second species, described following, form a compact group with a deep-water range extending from Indonesia to the Philippines. A feature of these shells is the flat-sided steeply descending whorls, with the peripheral angle right down at the lower suture. The style of sinus, with the outer lip produced far forward, the presence of a leaf-shaped operculum with a terminal nucleus (pl. 263), and a paucispiral, small, depressed-globose, smooth protoconch, combine to indicate *Leucosyrinx* as the most acceptable genus. The group, however, is readily distinguished from typical *Leucosyrinx* by the low situation of the peripheral angle, a feature which has already been employed as a criterion of distinction between the genera *Makiyamaia* and *Turricula*.

**Description**—Shell moderately large, 45-46 mm. (1¾ inches) in height, of light build, fusiform, with a narrow, pyramidal, flat-sided spire and rounded body-whorl, which rapidly contracts basally to a rather long, straight, unnotched anterior canal. Spire angle 30-32°. Whorls 10½, including a small smooth depressed-globose protoconch of 1½ whorls, the tip asymmetric. Post-nuclear whorls straight sided and steeply descending to a bluntly rounded peripheral keel, immediately above the lower suture. The body-

whorl is broadly angulate at the periphery, then rapidly contracted over the base. The axial sculpture consists of comma-like subsutural crenulations and short oblique peripheral node-like axials, 17-18 per whorl. The spiral sculpture is of closely spaced and regularly incised narrow grooves, commencing at the middle of the peripheral axials and extending right to the end of the anterior canal. The shoulder slope is smooth and polished except for 2 or 3 very weak spiral threads above and odd retrocurrent wrinkles below, which cross the regular axial growth lines defining the successive sinus curves. The sinus is broadly shallowly arcuate, occupies the upper two thirds of the shoulder slope and is confluent below with a great forward extension of the outer lip. The whole shell is covered by a very thin yellowish-buff periostracum. Ground colour of the shell opaque white. Operculum small, 6 mm. in height, less than half the height of the aperture, exclusive of the canal, thin, horny, yellowish, leaf-shaped, with a terminal nucleus. (Pl. 263).

#### Measurements (mm.)—

height	width	
45.0	15.75	holotype
46.0	15.00	Gulf of Boni, 484 fathoms, Celebes

#### Synonymy—

1913 *Surcula pyramidalis* Schepman, Siboga Exped., monogr. 49e, pt. 5, p. 423, pl. 27, fig. 10.

**Types**—The holotype is in the Zoological Museum, Amsterdam.

**Records**—TIMOR SEA: 10° 48.6'S., 123° 23.1'E., 918 metres, fine grey mud (type locality). BORNEO, 260 fathoms off Mabul Island, Sibuko Bay (Albatross Sta. 5591, USNM). CELEBES: 484 fathoms off Olang Point, Gulf of Boni (Albatross Sta. 5656, USNM).

#### *Leucosyrinx* cf. *pyramidalis* (Schepman)

(Pl. 264, figs. 4, 5)

**Range**—Borneo, Celebes and Molucca Passage, 260-484 fathoms.

**Remarks**—This form is not named at present since there is some doubt regarding its status. Certainly it is easily separable from the typical form of the species in its wider spire angle, 36°-40°, more broadly rounded periphery and sub-obsolete to obsolete protractive axial folds, not nodes, over the last half whorl. The spiral sculpture and other details are as in the typical species.

This form occurs with the typical species over a similar geographic and bathymetric range, but intergradation between the two was not observed



3

Plate 263. Operculum of *Leucosyrinx* (*Sibogasyrinx*) *pyramidalis* (Schepman).

in the twenty specimens examined. Since no animals were available the possibility that the two forms may be correlated with sex cannot be ignored.

*Measurements (mm.)—*

height	width	
57.5	18.5	484 fathoms off Olang Point, Celebes
51.0	17.0	310 fathoms off Mabul Island, Borneo
49.2	15.5	347 fathoms off Sipadan Island, Borneo

*Records*—BORNEO: off Mabul Island, Sibuko Bay, sand and mud, 260 fathoms (Albatross Sta. 5589); S. E. of Mabul Island, Sibuko Bay, grey mud and sand, 310 fathoms (Albatross Sta. 5590); E. of Sipadan Island, Sibuko Bay, green mud, 347 fathoms (Albatross Sta. 5586); off Si Amil Island, Sibuko Bay, fine sand and green mud, 292 fathoms (Albatross Sta. 5584). CELEBES: off Olang Point, Gulf of Boni, grey mud, 484 fathoms (Albatross Sta. 5656). Molucca Passage, grey sand and mud, 435 fathoms (Albatross Sta. 5619 USNM).

*Leucosyrinx archibenthalis*  
*new species* Powell

(Pl. 264, figs. 6, 7)

*Range*—Off the Philippines in 340 to 505 fathoms.

*Remarks*—This species is quite distinct from both *pyramidalis* and from its wider less angulate form. The spire is proportionately much taller and narrower, only 25°, compared with 30-40° for *pyramidalis*. The height of the spire is considerably more than that of the aperture plus the canal, the reverse being the case in *pyramidalis*. Also, the spiral sculpture is densely lirate over

the whole shell, being equally strong over the shoulder slope.

*Description*—Shell of moderate size, 43 mm. (1¾ inches) in height, fusiform, with a tall very narrow flat-sided spire, which is about one and one fifth times the height of the aperture and canal. Spire angle 25°. Whorls 13½, including a small globose protoconch of 1½ smooth whorls, with an asymmetric tip. Spire-whorl outlines quite straight and steeply descending to a narrowly rounded flange-like peripheral carina, situated right at the lower suture. Body-whorl distinctly angled by the peripheral carina, and rapidly contracted over the base to a moderately long almost straight and unnotched anterior canal. Axial sculpture of rounded peripheral nodes, about 13 per whorl, but these become obsolete over the last two whorls, and there are no subsutural nodes or folds. Spiral sculpture of dense well defined and regular spiral lirae, 11-12 on the shoulder area. Sinus as in *pyramidalis*, its lower limb confluent with a great forward projection of the outer lip. Colour opaque white, covered by a thin pale buff periostracum.

*Measurements (mm.)—*

height	width	
43.5	13.0	holotype

*Types*—The holotype is in the United States National Museum.

*Records*—PHILIPPINES: Iligan Bay, off Binuni, 505 fathoms (holotype) (Albatross Sta. 5513); off Sombrero Island, Balayan Bay, fine sand, 340 fathoms (Albatross Sta. 5114, USNM).

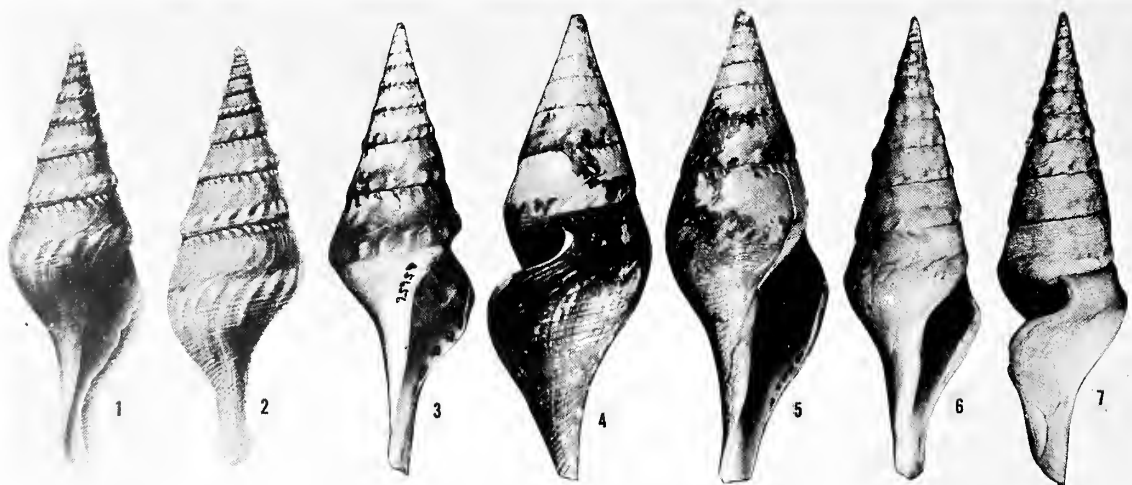


Plate 264. Figs. 1-5, *Leucosyrinx* (*Sibogasyrinx*) *pyramidalis* (Schepman). Figs. 1, 2, Timor Sea, 918 metres. 45.0 mm. (from Schepman, 1913, pl. 27, figs. 10a, b). Fig. 3, Celebes, 484 fathoms. Gulf of Boni. 46.0 mm. Figs. 4, 5, cf. *pyramida-*

*lis*. Borneo, 310 fathoms, Sibuko Bay. 49.2 mm. Figs. 6, 7, *Leucosyrinx* (*Sibogasyrinx*) *archibenthalis* Powell, *new species*. Holotype, Philippines, Iligan Bay, 505 fathoms. 43.5 mm.



## Genus *Apiotoma* Cossmann, 1889

Type: *Pleurotoma pirulata* Deshayes, 1834

The shells of this genus are characterized by their attenuate-fusiform shape, with tall spire of rapidly increasing whorls, long unnotched anterior canal, spiral dominance of the sculpture (in most species), a more or less sunken shoulder area, and a globose to narrowly conic smooth protoconch of  $1\frac{1}{2}$ - $2\frac{1}{2}$  whorls, with a small asymmetric tip.

The type species (pl. 265, fig. 1) is from the Eocene of the Paris Basin, a Miocene species is claimed from the Nanggulan beds of Java, and a further group of Miocene species occur in Victoria, Australia, Recent species such as *pluteola* from West Africa and two deep water species from Borneo and the Philippines, described following, seem to belong also.

### Synonymy—

1889 *Apiotoma* Cossmann, Catalogue illustre des Coquilles Fossiles de l'Eocene des Environs de Paris. Ann. Soc. Malac. Belgique, vol. 24, p. 263. Type by original designation: *Pleurotoma pirulata* Deshayes, 1834.

### Key to the Recent and Tertiary species of *Apiotoma*

- A. Shell narrowly fusiform, spire angle  $20^{\circ}$ - $31^{\circ}$ 
  1. Axial ribs or nodes absent
    - Peripheral angle slight
    - Spiral sculpture of few strong cords
    - Interstices smooth
      - Spire angle  $20^{\circ}$  ..... *granti* (Pritchard)
      - Spire angle  $30^{\circ}$  ..... *arntzenii* (K. Martin)
    - Interstices reticulated
      - Spire angle  $31^{\circ}$  ..... *deningeri* (K. Martin)
  2. Axial ribs or nodes on early whorls only
    - Peripheral angle slight
    - Spiral sculpture fine and indistinct
    - Spire outlines concave
      - ..... *tibiaformis tibiaformis* Powell n. sp
    - Spire outlines straight
      - ..... *tibiaformis sibukoensis* Powell n. subsp.
    - Peripheral angle distinct
      - Spiral sculpture moderately strong *chapplei* Powell
      - Spiral sculpture fine and dense ..... *bassi* Pritchard
  3. Axial sculpture of dense protractive growth lines throughout
    - Peripheral angle distinct
    - Spiral sculpture dense, distinct . . *pritchardi* Powell
    - Peripheral angle strong
    - Spiral sculpture stronger on base
      - ..... *hypermece* (Cossmann & Pissarro)
  4. Axial sculpture of weak peripheral nodules throughout
    - Peripheral angle prominent
    - Spiral sculpture of a few strong cords
    - Interstices with axial growth lines
      - ..... *vredenburgi* (Cossmann & Pissarro)
- B. Shell broadly fusiform, spire angle  $33^{\circ}$ - $35^{\circ}$ 
  - Peripheral nodules absent ..... *janjukiensis* (Chapple)
  - Peripheral nodules strong, 12-14 per whorl
    - ..... *balcombensis* Powell

***Apiotoma pritchardi* Powell, 1944**

(Pl. 265, fig. 2)

**Range**—Torquay, Victoria, Australia, (Janjukian, Oligocene).

**Remarks**—The style of sculpture in this species is most in accord with that of the Parisian Eocene type of the genus. It consists of numerous closely

spaced narrow spiral cords, much weaker within the shoulder sulcus; the whole crossed by dense fine axial growth threads, which delicately, protractively, and somewhat irregularly, lattice the interstices. The protoconch is globose-conic, of  $2\frac{1}{2}$  whorls, the tip small, asymmetric and slightly projecting. Axial nodes are entirely absent and the suture is very faintly submargined only over the first two or three post-nuclear whorls.

**Measurements (mm.)—**

height	width
20.0	6.0

**Synonymy—**

1944 *Apiotoma pritchardi* Powell, Rec. Auck. Inst. Mus., vol. 3, no. 1, p. 20, pl. 3, fig. 7.

**Types**—The holotype is in the Auckland Museum, New Zealand.

***Apiotoma balcombensis* Powell, 1944**

(Pl. 265, fig. 3)

**Range**—Victoria, Australia, Balcombe Bay (Balcombian, middle Miocene).

**Remarks**—Although the rather strongly developed axial folds, persisting over the whole shell, suggest alliance with *Comitas* rather than with *Apiotoma*, the species is not dissimilar from the other Australian species assigned to *Apiotoma*, particularly in respect to the protoconch, sculptural detail of the early post-nuclear whorls and the sunken shoulder sulcus. Except for the presence of strong axial folds the species stands close to *janjukiensis* Chapple, 1934.

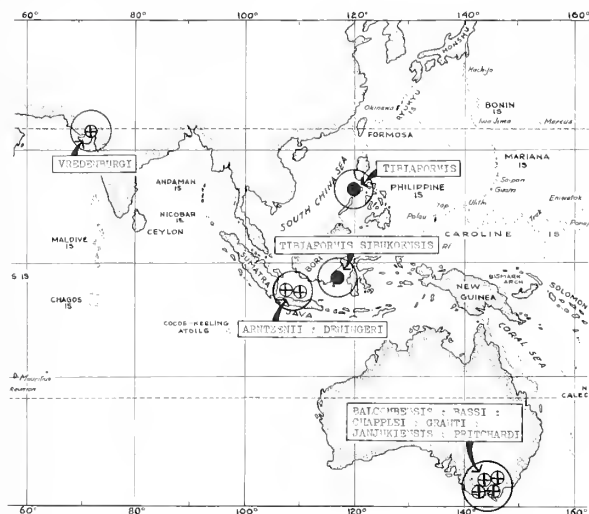


Plate 266. Geographical distribution of the Recent *Apiotoma tibiaformis* Powell, new species, subspecies *sibukoensis* Powell, new subspecies, and the Tertiary *A. arntzenii* K. Martin, *A. balcombensis* Powell, *A. bassi* Pritchard, *A. chapplei* Powell, *A. deningeri* K. Martin, *A. granti* (Pritchard), *A. janjukiensis* (Chapple), *A. pritchardi* Powell and *A. vredenburghi* (Cossmann & Pissarro). The type species of the genus is from the Eocene of the Paris Basin.

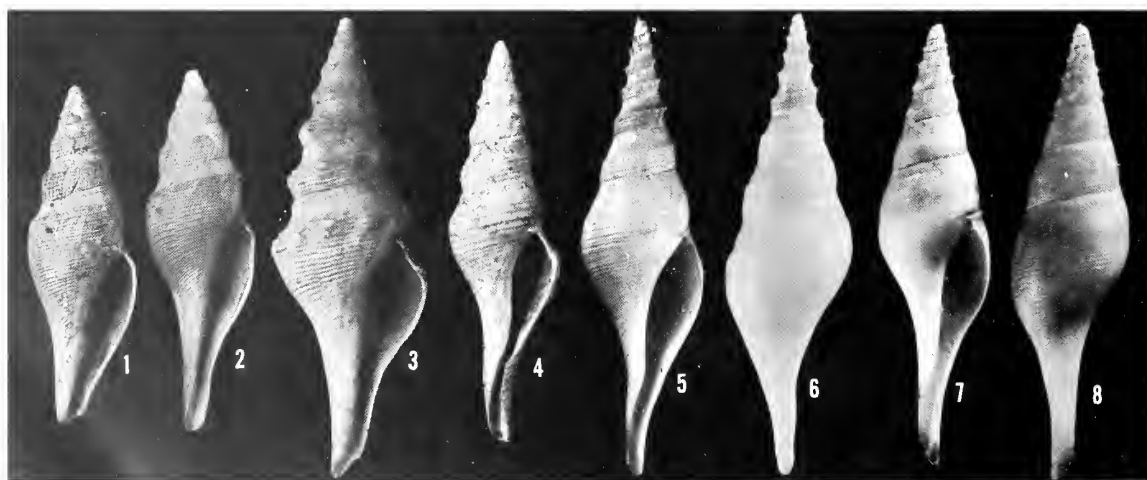


Plate 265. Fig. 1, *Apiotoma pirulata* (Deshayes). Paris Basin, Eocene. 19.0 mm. (type of *Apiotoma*). Fig. 2, *Apiotoma pritchardi* Powell. Holotype, Torquay, Victoria, Oligocene. 20.0 mm. Fig. 3, *Apiotoma balcombensis* Powell. Holotype, Balcombe Bay, Victoria, Miocene. 31.3 mm. Fig. 4, *Apiotoma chapplei* Powell. Holotype, Balcombe Bay,

Victoria, Miocene. 18.2 mm. Figs. 5, 6, *Apiotoma tibiaformis* Powell, new species. Holotype, off Cabra Island, Lubang, 525 fathoms, Philippines. 45.0 mm. Figs. 7, 8, *Apiotoma tibiaformis sibukoensis* Powell, new subspecies. Holotype, off Sipadan Island, Sibuko Bay, 347 fathoms, Borneo. 38.0 mm.

*Description*—Shell of moderate size, 31.3 mm. (1¼ inches) in height, elongate-fusiform, with spire almost equal to height of aperture plus canal. Protoconch globose, of 2½ smooth whorls, with a small asymmetric tip. Spiral sculpture of 6-7 narrow but sharply raised cords, extending over the peripheral bulge to the lower suture, about 40 on body-whorl from the periphery to the end of the long straight unnotched anterior canal. There are 6-7 distinct spiral lirations on the shoulder or sinus area. Axials broad, fold-like, restricted to the peripheral bulge, 12 per whorl, strongest on later whorls. Sinus rather deep, constricted by the subsutural fold.

*Measurements (mm.)*—

height	width
31.3	10.6

*Synonymy*—

1944 *Apiotoma balcombensis* Powell, Rec. Auck. Inst. Mus., vol. 3, no. 1, p. 20, Pl. 7, fig. 10.

*Types*—The holotype is in the Auckland Museum, New Zealand.

***Apiotoma tibiaformis*  
new species Powell**

(Pl. 265, figs. 5, 6)

*Range*—Philippines, off Cabra Island, Lubang, 525 fathoms.

*Remarks*—This species, a subspecies from off Borneo, and the Victorian Miocene *chapplei*, have several features in common, i.e., rapidly increasing whorls, regular raised spirals over all the post-nuclear whorls, and the addition of crisp regular axials on the upper spire whorls.

*Description*—Shell moderately large, 45 mm. (1¾ inches) in height, of light build, elongate-fusiform, with tall attenuated, turreted spire, moderately inflated body-whorl, and a long slightly flexuous unnotched anterior canal. Whorls 8½ +, apical whorls missing. Spire a little less than height of aperture plus canal. Spire angle over the first five whorls 20 degrees, then increasing to 25 degrees, which results in overall concave outlines. All post-nuclear whorls with a median carination, strong above but gradually becoming less prominent, and slightly above middle whorl height, over the last two whorls. The carination is demarked by a slightly sunken, almost flat, steeply descending shoulder area. Suture over the first four whorls submargined by a row of small gemmules, but unmargined over later whorls. First 4-5 post-nuclear

whorls with oblique crisp axial folds, commencing strongly at the periphery but barely reaching the lower suture, 14-15 per whorl. Spiral sculpture; shoulder sulcus smooth, except for about five very indistinct threads, which develop over the last two whorls. Periphery with three closely spaced weak cords which override the axials; below this there are 3-4 much stronger flat-topped cords, with equal interspaces; similar sculpture continued over the base but the cords become weaker and wider-spaced over the neck and the anterior canal. Some of the wider cords of the body-whorl are faintly bisected by a very narrow groove. Sinus indicated as broadly arcuate, but deep, occupying the whole of the shoulder slope, its lower edge continued far forward, parallel to the suture, and then confluent with the protractively arcuate swing of the thin outer lip. Colour pure white.

*Measurements (mm.)*—

height	width
45.0	12.0

*Types*—The holotype is in the United States National Museum, Wash. Albatross Sta. 5274; USNM 237537.

***Apiotoma tibiaformis*  
new subspecies sibukoensis Powell**

(Pl. 265, figs. 7, 8)

*Range*—Borneo, off Sipadan Island, Sibuko Bay, 347 fathoms, grey mud.

*Remarks*—The subspecies differs from the species in having a uniform spire angle of about 30 degrees, which results in straight, not concave outlines for the spire. The body-whorl is narrower and the spiral sculpture much less prominent, with only linear interspaces. The early whorls have a similar gemmate subsutural margin, the axials are stronger, fewer peripheral nodes, 10-11 per whorl, the shoulder is not sunken, and the peripheral angulation is subobsolete over the later whorls. Other features as in the species.

*Measurements (mm.)*—

height	width
38.0	9.5

*Types*—The holotype is in the United States National Museum, Washington, Albatross Sta. 5586 USNM 290006.

***Apiotoma bassi* Pritchard, 1904**

*Range*—Cape Otway near Cape Flinders, Victoria, Australia, (Janjukian, Oligocene).



*Remarks*—This species is closely related to *pritchardi* Powell, 1944, differing mainly in having blunt nodules on the peripheral keel over the early whorls and a long gradually contracted body-whorl.

*Description*—Shell of moderate size, 24-45 mm. (1-1¾ inches) in height, with tapered spire, less than half the height of the shell. Whorls angulated by a strong keel, at above middle whorl height, 7-8, plus a small smooth protoconch of 1½-2 whorls, the tip obliquely immersed. Surface of shell covered with fine spiral threads of unequal strength, crossed by stronger lines and undulations of growth. Sinus broad, moderately deep, on the shoulder slope, which is slightly sunken.

*Measurements (mm.)—*

height	width
45.0	13.0
33.0	10.0
24.0	8.0

*Synonymy—*

1904 *Apiotoma bassi* Pritchard, Proc. Roy. Soc. Vict., vol. 17, p. 328, pl. 19, fig. 11.

***Apiotoma chapplei* Powell, 1944**

(Pl. 265, fig. 4)

*Range*—Victoria, Australia (Balcombian, middle Miocene).

*Description*—Shell small, 18.2 mm. (¾ inch) in height, attenuated-fusiform, with narrow sharply raised rather distant spiral cords, and the addition of blunt peripheral nodules, 11 per whorl, over the first three post-nuclear whorls. Whorls 8½, including a narrowly conic protoconch of 2½ smooth whorls, the tip slightly asymmetric. Suture submargined by a strong spiral cord, followed by an almost smooth slightly sunken shoulder area to the median placed peripheral angle, below which the spiral cords commence.

*Measurements (mm.)—*

height	width
18.2	5.0

*Synonymy—*

1944 *Apiotoma chapplei* Powell, Rec. Auck. Inst. Mus., vol. 3, no. 1, p. 21, pl. 3, fig. 6.

*Types*—The holotype is in the Auckland Museum, New Zealand.

*Records*—AUSTRALIA: Victoria, Balcombe Bay (type locality); Muddy Creek, lower beds; Murgheboluc (Balcombian, middle Miocene).

***Apiotoma arntzenii* (K. Martin, 1914)**

(Pl. 267, figs. 1-3)

*Range*—Nanggulan Beds, Miocene of Kali Songo, Java.

*Remarks*—This very spectacular fossil is closely allied to another species of Martin's, *deningeri*; both are from the Nanggulan of Java.

*Description*—The shell of *arntzenii* is of moderate size, 41 mm. (1⅝ inches) in height, very narrowly elongate-fusiform, with an attenuated spire and a long narrow body-whorl, very gradually tapered to a long straight unnotched anterior canal. The sculpture is of rather distant narrow sharply raised spiral cords, one subsutural, one forming the peripheral carina and a third just above the lower suture; about 20 on the body-whorl from below the carina to the end of the anterior canal; interstices smooth. The sinus is not clearly shown but is certainly on the slightly sunken shoulder slope. The protoconch is described as of two polished whorls with a blunt tip.

*Measurements (mm.)—*

height	width
41.0	—

*Synonymy—*

1914 *Surcula (Apiotoma) arntzenii* K. Martin, Die Fauna des Obereocäns von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2, no. 4, p. 113, pl. 1, fig. 9.

1919 *Surcula arntzenii* K. Martin, Palaeozool. Kenntnis von Java, Leiden, p. 74.

1931 *Surcula arntzenii* Martin, van der Vlerk, Leidsche Geol. Meded., vol. 5, p. 219.

***Apiotoma deningeri* (K. Martin, 1914)**

(Pl. 267, fig. 4)

*Range*—Nanggulan Beds, Miocene of Java, Indonesia.

*Remarks*—This species appears to reach only half the size of *arntzenii*, but it closely resembles that species in form and in sculpture. The chief differences for *deningeri* are a slightly inflated upper part of the body-whorl, and a reticulated intercostal surface pattern of crisp spiral threads, one in each interspace, crossed by equally distinct axial threads.

*Measurements (mm.)—*

height	width
20.0	—

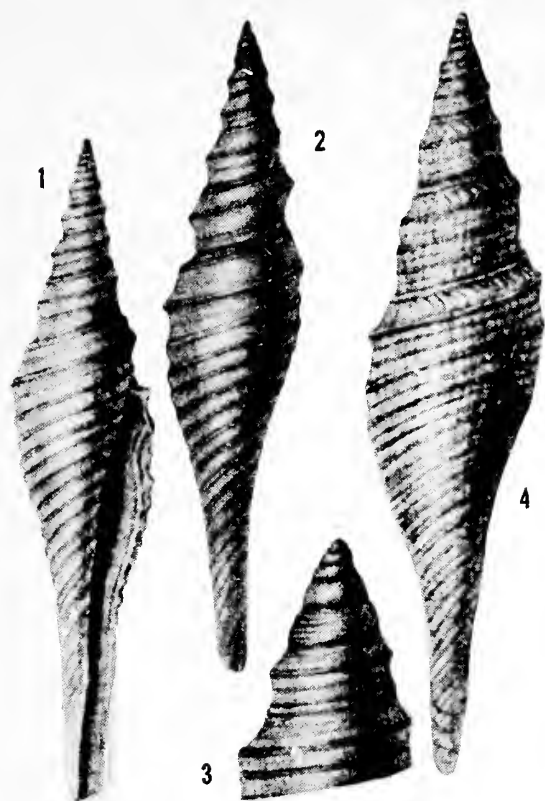


Plate 267. Figs. 1-3, *Apiotoma arntzeni* (K. Martin), Nanggulan Miocene of Kali Songo, Java. Fig. 4, *Apiotoma deningeri* (K. Martin). Nanggulan Miocene of Java (from K. Martin, 1914, pl. 1, figs. 9, 10).

#### Synonymy—

- 1914 *Surcula* (*Apiotoma*) *deningeri* K. Martin, Die Fauna des Obereocans von Nanggulan auf Java. Samml. Geol. Reichs-Mus., Leiden, vol. 2, no. 4, p. 113, pl. 1, fig. 10.  
 1919 *Surcula deningeri* K. Martin, Palaeozool. Kenntnis von Java, Leiden, p. 74.  
 1931 *Surcula deningeri* K. Martin, Vlerk, Leidsche Geol. Meded., vol. 5, p. 219.

#### *Apiotoma granti* (Pritchard, 1904)

**Range**—Victoria, Australia, Muddy Creek, lower beds (Balcombian, middle Miocene).

**Remarks**—This very distinctive shell is easily recognized by its very narrow, elongately-fusiform shape, with tall tapered spire and long straight unnotched anterior canal. Whorls 9, plus a small smooth protoconch of  $2\frac{1}{2}$  whorls. Sculpture of spiral lirae, with 3-4 stronger threads encircling the middle of each whorl. Whorls weakly angled above middle whorl height, defining a moderately wide, slightly sunken, steeply descending shoulder area. Sinus broadly rounded and deep, occupying most of the shoulder area.

#### Measurements (mm.)—

height	width
63.0	13.0

#### Synonymy—

- 1904 *Pleurotoma granti* Pritchard, Proc. Roy. Soc. Vict., vol. 17, p. 336, pl. 19, fig. 3.

#### *Apiotoma janjukiensis* (Chapple, 1934)

**Range**—Torquay, Bird Rock Cliffs, Victoria, Australia (Janjukian, Oligocene).

**Remarks**—This species is rather broadly fusiform, with a very long and straight unnotched anterior canal, a wide steep slightly sunken shoulder area, four or five strong spiral lirae encircling the peripheral bulge, which is rounded, and there is no axial sculpture, except for very weak growth lines. It appears to be related to *granti* Pritchard, 1904, which has similar sculpture but is much more slender.

**Description**—Shell of moderate size, 31 mm. ( $1\frac{1}{4}$  inches) in height, broadly fusiform, with a tall but relatively broad spire, inflated body-whorl and long straight slender and gradually tapered unnotched anterior canal. Whorls about 9, including a small smooth protoconch of two whorls, the tip slightly oblique.

#### Measurements (mm.)—

height	width
31.0	10.0

#### Synonymy—

- 1934 *Turris janjukiensis* Chapple, Mem. Nat. Mus. Melbourne, vol. 8, p. 163, pl. 19, figs. 2, 2a.

**Types**—The holotype is in the National Museum, Melbourne, Australia.

#### *Apiotoma hypermeces* (Cossmann & Pissarro, 1909)

(Pl. 268, fig. 3)

**Range**—Upper Ranikot beds, Eocene of Jhirak, India.

**Remarks**—From the original figures this species appears to be quite distinctive.

**Description**—Shell of moderate size, 27 mm. (1 inch) in height, very narrowly fusiform, with a tall spire and moderately long anterior canal. There is a deeply sunken smooth shoulder sulcus, and the sculpture is of bold, smooth, keel-like spiral cords. The peripheral keel sharply angulates the whorls at almost two thirds the whorl height, and between the keel and the lower suture there are two strong spiral cords. The suture is submar-

gined by a moderately strong smooth spiral, and strong smooth cords continue over the base, but become more numerous and linear-spaced over the lower base, neck and anterior canal.

*Measurements (mm.)—*

height	width
27.0	10.0

*Synonymy—*

- 1909 *Surcula (Apiotoma) hypermeces* Cossmann & Pissarro, Palaeont. Indica, n. s., vol. 3, Mem. 1, p. 9, pl. 2, figs. 11-13.  
 1921 *Surcula (Ancistrosyrinx) terebralis* var. *hypermeces* Cossmann & Pissarro, Rec. Geol. Surv. India, vol. 53, p. 88.

? *Apiotoma vredenburgi* (Cossmann & Pissarro, 1909)

(Pl. 268, figs. 1, 2)

*Range*—Lower beds of the upper Ranikot, 2 miles east of Kandaira, India (Eocene).

*Remarks*—This species was originally described as an *Ancistrosyrinx*, referred to *Apiotoma* by Vredenburg in 1928 and reassigned to *Ancistrosyrinx* by Cox in 1930. The characters of *vredenburgi* are an elongate-fusiform shell with a tall spire and a long straight canal. There is a deeply sunken shoulder slope, the sculpture is of strong spiral cords, well developed only on the base and neck and the protoconch is conoidal of at least four smooth whorls. In *Ancistrosyrinx* the protoconch is slender and smooth but of only 1½ whorls, the peripheral carina bears coronated frills and typically the shoulder slope is bisected by a spiral lamella.

The nuclear characters, slender adult shape and style of sculpture of *vredenburgi* more closely resemble those of the New Zealand Tertiary *Zemacies*, but in that genus the adult whorls are rather loosely coiled and rapidly increasing.

Vredenburg (1928) claimed close resemblance of the Indian species to the Parisian Eocene type of *Apiotoma*, which it does, except for the protoconch, which in the Parisian *pirulata* is smooth, globose to narrowly conic of 1½-2½ whorls, with a small asymmetric tip. The genus *Apiotoma* is preferred, but only provisionally, until material can be examined.

*Measurements (mm.)—*

height	width
32.0 +	10.0

*Synonymy—*

- 1909 *Surcula (Ancistrosyrinx) vredenburgi* Cossmann & Pissarro, Palaeont. Indica, n. s., vol. 3, Mem. no. 1, p. 10, pl. 1, figs. 29, 30.  
 1928 *Surcula (Apiotoma) vredenburgi* Cossmann & Pissarro, Vredenburg, Palaeont. Indica, n. s., vol. 10, Mem. no. 4, p. 24.  
 1930 *Turricula (Ancistrosyrinx) vredenburgi* (Cossmann & Pissarro), Cox, Palaeont. Indica, n. s., vol. 15, pt. 8, p. 195.

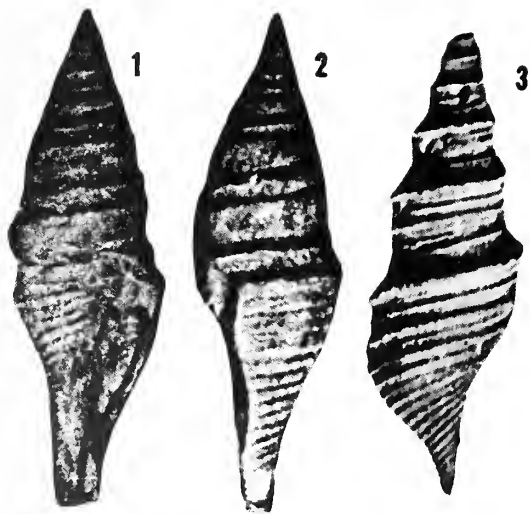


Plate 268. Figs. 1, 2, *Apiotoma vredenburgi* (Cossmann & Pissarro). Ranikot, Eocene, Kandaira, India. 32 mm. (from Cossmann & Pissarro, 1909, pl. 1, fig. 29, 30). Fig. 3, *Apiotoma hypermeces* (Cossmann & Pissarro). Ranikot, Eocene, Jhirak, India. 27.0 mm. (from Cossmann & Pissarro, 1909, pl. 2, fig. 11).



**Apiotoma haydeni (Cox, 1930)**

(Pl. 269)

*Range*—The Hangu shales, lower Eocene of the Samana Range, India.

*Remarks*—This species is easily recognised by its strong relatively few spiral cords, including a very strong subsutural margining one. Between this subsutural cord and the peripheral one there is the characteristic deeply sunken shoulder sulcus, and from the peripheral angle to the lower suture there are four spiral cords on the spire-whorls.

This species was originally described as an *Ancistrosyrix* but its relationship is clearly with such Eocene species, assumed to be *Apiotoma*, as *Surcula (Apiotoma) hypermeces* Cossmann and Pissarro, 1909, from the upper Ranikot of Jhirak, India, and *Surcula (Ancistrosyrix) vredenburgi* Cossmann and Pissarro, 1909, also from the Ranikot of India.

The present species seems to be nearest to *hypermeces*, in which the spirals are fewer and the shoulder concavity wider.

*Measurements (mm.)—*

height	width
35.8	11.0

*Synonymy—*

1930 *Surcula (Ancistrosyrix) haydeni* Cox, Mem. Geol. Surv. India; Pal. Indica, new ser., vol. 15, pt. 8, p. 195, pl. 20, figs. 13a, b.



Plate 269. *Apiotoma haydeni* (Cox). Hangu shales of the Samana Range, India. Holotype, 35.8 mm. (from Cox, Mem. Geol. Surv. India, Pal. Indica, new ser., 15 (8), p. pl. 20, figs. 13a, b).

*[These occasional blank areas occur between genera and subgenera to permit the insertion of new material and future sections in their proper systematic sequence.]*

# Genus *Zemacies* Finlay, 1926

Type: *Zemacies elatior* Finlay, 1926

A characteristic New Zealand and Australian Tertiary genus resembling *Apiotoma* of the Parisian Eocene in general features but with a narrowly conical 4-5 whorled smooth and glossy

protoconch, more like that of *Insolentia* than that of *Apiotoma*, which is paucispiral, conoidal-mamillate. Adult shell large, up to 80 mm., narrowly fusiform, with drawn out loosely coiled whorls. Sinus very deep, on the shoulder slope, then swinging forward and downward in a broad arc far past its point of origin above. Outer lip profile with a weak insinuation low on the base, where it is constricted to form the anterior canal.

Range—Paleocene to lower Pliocene of New Zealand and Oligocene of Victoria, Australia.

## Synonymy—

1926 *Zemacies* Finlay, New Shells from New Zealand Tertiary Beds, pt. 2, Trans. N. Z. Inst., vol. 56, p. 252. Type by original designation: *Zemacies elatior* Finlay, 1926.

## Key to New Zealand and Australian Tertiary species of *Zemacies*

- A. Shell narrowly fusiform; whorls gradually increasing  
Shoulder steep, wide and shallow  
Shell very large, up to 100 mm. Axials obsolete  
..... *gravidia* (Marshall)  
Shell up to 30 mm. Axials obsolete  
..... *inexpectata* Powell  
Shell small, 24 mm. Axials 13 per whorl, obsolete over lower whorls..... *immatura* Finlay & Marwick
- B. Shell very narrow; whorls rapidly increasing  
Axials obsolete..... *awakinoensis* Powell  
Axials oblique, narrow, not reaching either suture  
Axials on early whorls only..... *elatior* Finlay  
Axials persistent throughout  
Body-whorl narrow, parallel-sided medially  
..... *lividorupis* Laws  
Body-whorl wider at periphery, then regularly tapered..... *prendrevillei* Marwick  
Axials nodular, more or less restricted to periphery  
Subsutural fold strong..... *marginalis* (Marshall)  
Subsutural fold weak, obsolete on later whorls  
Nodules 7 per whorl, strong throughout  
..... *armata* Powell  
Nodules 12 per whorl, obsolete below  
..... *hamiltoni* (Hutton)  
Subsutural fold obsolete  
Nodules strong; on raised peripheral fold  
16 per whorl..... *ordinaria* (Marshall)  
21-22 per whorl..... *climacota* (Suter)  
Nodules weaker; no raised fold, 17 per whorl  
..... *simulacrum* Laws
- C. Shell very slender, drawn out unwound appearance  
Axials long, narrow and obliquely flexuous  
..... *torticostata* (Marshall)



***Zemacies armata* Powell, 1942**

*Locality*—New Zealand, abandoned railway, Waihao Downs, South Canterbury (Bortonian, middle Eocene). The type is in the Auckland Museum.

*Synonymy*—

1942 *Zemacies armata* Powell, Bull. no. 2, Auck. Inst. Mus., p. 66, pl. 4, fig. 6.

***Zemacies awakinoensis* Powell, 1942**

*Locality*—New Zealand, N. Z. G. S. loc. 894, track at bend of Mokau River, ¾ mi. S. S. W. of Pukewhero Trig, Awakino North S. D. (Altonian, upper Miocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1942 *Zemacies awakinoensis* Powell, Bull. no. 2, Auck. Inst. Mus., p. 67, pl. 14, fig. 4.

***Zemacies climacota* (Suter, 1917)**

*Locality*—New Zealand, Komiti Bluff = Pakaurangi Point, Kaipara (Otaian, lower Miocene). The type is in the Otago Museum, Dunedin.

*Synonymy*—

1917 *Surcula climacota* Suter, N. Z. Geol. Surv. Pal. Bull., vol. 5, p. 50, pl. 12, fig. 15.

***Zemacies elatior* Finlay, 1926**

*Locality*—New Zealand, Clifden, band 4, Southland (Altonian, Miocene). The type is in the Auckland Museum.

*Synonymy*—

1926 *Zemacies elatior* Finlay, Trans. N. Z. Inst., vol. 56, p. 252.

***Zemacies grvida* (Marshall, 1919)**

*Locality*—New Zealand, Hampden, North Otago (Bortonian, middle Eocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1919 *Surcula grvida* Marshall, Trans. N. Z. Inst., vol. 51, p. 231, pl. 16, fig. 4.

***Zemacies immatura* Finlay & Marwick, 1937**

*Locality*—New Zealand, Boulder Hill, Otago (Wangaloan, Paleocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1937 *Zemacies immatura* Finlay & Marwick, N. Z. Geol. Surv. Pal. Bull. no. 15, p. 87, pl. 12, fig. 10.

***Zemacies hamiltoni* (Hutton, 1905)**

(Pl. 271, fig. 1)

*Locality*—New Zealand, Waihao Forks, South Canterbury (Bortonian, middle Eocene). The type is in the Canterbury Museum, Christchurch.

*Synonymy*—

1905 *Pleurotoma hamiltoni* Hutton, Trans. N. Z. Inst., vol. 37, p. 472, pl. 44, fig. 1.

***Zemacies lividorupis* Laws, 1935**

*Locality*—New Zealand, Blue Cliffs, South Canterbury (Otaian, lower Miocene). The type is in the Auckland Museum.

*Synonymy*—

1935 *Zemacies lividorupis* Laws, Trans. Roy. Soc. N. Z., vol. 65, p. 35, pl. 5, fig. 12.



Plate 270. Fig. 1, *Zemacies ordinaria* (Marshall). New Zealand, Altonian Miocene of Pakaurangi Point, Kaipara. 42.0 mm. Fig. 2, *Insolentia pareoraensis* (Suter). New Zealand, Awamoan lower Miocene of White Rock River, Canterbury. 20.0 mm.

**Zemacies marginalis (Marshall, 1919)**

*Locality*—New Zealand, Hampden, North Otago (Bortonian, middle Eocene). The types are in the New Zealand Geological Survey, Wellington.

*Synonymy*—

- 1919 *Surcula marginalis* Marshall, Trans. N. Z. Inst., vol. 51, p. 231, pl. 17, fig. 10.  
 1919 *Surcula equispiralis* Marshall, Trans. N. Z. Inst., vol. 51, p. 232, pl. 16, fig. 3.  
 1920 *Surcula hampdenensis* Marshall & Murdoch, Trans. N. Z. Inst., vol. 52, p. 134, pl. 6, fig. 7.

**Zemacies ordinaria (Marshall, 1918)**

(Pl. 270, fig. 1)

*Locality*—New Zealand, Pakaurangi Point, Kaipara (Otaian, lower Miocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

- 1918 *Surcula ordinaria* Marshall, Trans. N. Z. Inst., vol. 50, p. 268, pl. 20, fig. 4, 4a.

**Zemacies prendrevillei Marwick, 1928**

*Locality*—Chatham Islands, Flower-pot Harbour, Pitt Island (Opoitian, lower Pliocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

- 1928 *Zemacies prendrevillei* Marwick, Trans. N. Z. Inst., vol. 58, p. 489, 506, fig. 141.

**Zemacies simulacrum Laws, 1935**

*Locality*—New Zealand, Clifden, Southland (bed B, left bank of Waiau River). (Lillburnian, middle Miocene). The type is in the Auckland Museum.

*Synonymy*—

- 1935 *Zemacies simulacrum* Laws, Trans. Roy. Soc. N. Z., vol. 65, p. 34, pl. 5, fig. 11.

**Zemacies torticostata (Marshall, 1919)**

*Locality*—New Zealand, Hampden, North Otago (Bortonian, middle Eocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

- 1919 *Surcula torticostata* Marshall, Trans. N. Z. Inst., vol. 51, p. 232, pl. 17, fig. 7.

**Zemacies inexpectata Powell, 1944**

*Locality*—Australia, Torquay, lower beds, Victoria (Janjukian, Oligocene Miocene). The type is in the Auckland Museum.

*Synonymy*—

- 1944 *Zemacies inexpectata* Powell, Rec. Auck. Inst. Mus., vol. 3, no. 1, p. 21, pl. 7, f. 8.





## Synonymy—

- 1926 *Insolentia* Finlay, New Shells from New Zealand Tertiary Beds, pt. 2, Trans. N. Z. Inst., vol. 56, p. 252.  
 Type by original designation: *Surcula pareoraensis* (Suter, 1907) = *Pleurotoma pareoraensis* Suter, 1907.

Genus *Insolentia* Finlay, 1926

Type: *Insolentia pareoraensis* Suter, 1907

*Remarks*—A lower Tertiary New Zealand and Australian genus allied to *Turricula* but with a tall narrowly conical polygyrate protoconch of 3-4 smooth whorls. The adult shell is elongate-fusiform with a tall spire and a long rather straight unnotched anterior canal, a moderately broad flat rib submargining the suture and a rather deep sinus on the shoulder slope. The sculpture is predominantly axial.

*Range*—New Zealand, upper Eocene to Miocene; Australia, lower Miocene.

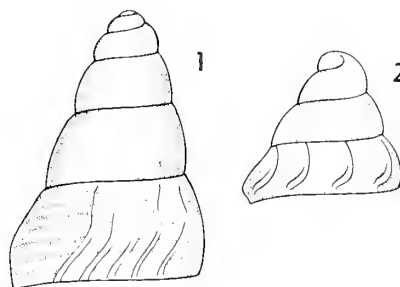


Plate 271. Protoconchs. Fig. 1, *Zemacies hamiltoni* (Hutton). New Zealand, Eocene. Fig. 2, *Insolentia pareoraensis* (Suter). New Zealand, Miocene.

Key to New Zealand Tertiary species of *Insolentia*

- A. Shell large, 35-60 mm.; shoulder not smooth
  - Surface with numerous narrow spiral cords and threads
  - Axial tubercles strong, narrowly rounded, peripheral, 12, persistent throughout . . . . . *laciuiata* (Suter)
  - Axial tubercles low, blunt, 9 per whorl obsolete on last whorl . . . . . *sertula* (Suter)
- B. Shell small, 6.5-15 mm.; shoulder smooth
  - Surface with sharp narrow spiral cords
  - Axials 9 per whorl above, obsolete below . . . . . *inaequalis* Marwick
  - Surface with very weak spiral sculpture
  - Axials 9-10 per whorl, strong, broadly rounded . . . . . *famelica* Marwick
  - Axials 9-10 per whorl, as pointed carinated tubercles . . . . . *elegantula* Powell
  - Axials about 16 per whorl, small peripheral tubercles . . . . . *seminuda* (Suter)
  - Surface with numerous linear-spaced spiral cords
  - Axials 14-15 per whorl, weak, very oblique . . . . . *pareoraensis* (Suter)

***Insolentia elegantula* Powell, 1942**

*Locality*—New Zealand, “Dyer’s Run”, Lower Waihao Valley, South Canterbury (Awamoan, lower Miocene). The type is in the Auckland Museum.

*Synonymy*—

1942 *Insolentia elegantula* Powell, Bull. no. 2, Auck. Inst. Mus., p. 64, pl. 10, fig. 7.

***Insolentia famelica* Marwick, 1931**

*Locality*—New Zealand, N. Z. G. S. loc. 1236, Ihungia series, Gisborne (Clifdenian Miocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1931 *Insolentia famelica* Marwick, N. Z. Geol. Surv. Pal. Bull., no. 13, p. 144, pl. 16, fig. 305.

***Insolentia inaequalis* Marwick, 1931**

*Locality*—New Zealand, N. Z. G. S. loc. 1236, Ihungia series, Gisborne (Clifdenian Miocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1931 *Insolentia inaequalis* Marwick, N. Z. Geol. Surv. Pal. Bull., no. 13, p. 144, Pl. 16, fig. 306.

***Insolentia laciniata* (Suter, 1917)**

*Localities*—New Zealand, Waihao Downs (*laciniata*); Hampden, Otago (*curialis*) (Bortonian, Eocene). The types are in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1917 *Surcula laciniata* Suter, N. Z. Geol. Surv. Pal. Bull., no. 5, p. 50, pl. 6, fig. 7.  
1920 *Turris curialis* Marshall & Murdoch, Trans. N. Z. Inst., vol. 52, p. 133.

***Insolentia seminuda* (Suter, 1917)**

*Locality*—New Zealand, tuffs interbedded in Amuri limestone, Coleridge Creek, Trelissick Basin, Canterbury (Miocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1917 *Surcula seminuda* Suter, N. Z. Geol. Surv. Pal. Bull., no. 5, p. 52, pl. 12, fig. 16.

***Insolentia pareoraensis* (Suter, 1907)**

(Pl. 270, fig. 2; Pl. 271, fig. 2)

*Locality*—New Zealand, White Rock River, South Canterbury (Awamoan, lower Miocene). The types are in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1907 *Pleurotoma pareoraensis* Suter, Proc. Malac. Soc., London, vol. 7, p. 208, pl. 18, fig. 3.  
1917 *Surcula obliquecostata* Suter, N. Z. Geol. Surv. Pal. Bull., no. 5, p. 52, pl. 6, fig. 11.

***Insolentia sertula* (Suter, 1917)**

*Locality*—New Zealand, Waihao Down, South Canterbury (Bortonian, middle Eocene). The type is in the New Zealand Geological Survey, Wellington.

*Synonymy*—

1917 *Surcula sertula* Suter, N. Z. Geol. Surv. Pal. Bull., no. 5, p. 53, pl. 6, f. 13.

***Insolentia johnstoni* (Tenison-Woods, 1877)**

*Locality*—Tasmania, Table Cape (Langfordian, lower Miocene).

*Synonymy*—

1877 *Pleurotoma johnstoni* Tenison-Woods, Proc. Roy. Soc. Tasmania for 1876, p. 105.  
1944 *Insolentia johnstoni* (Tenison-Woods), Powell, Rec. Auck. Inst. Mus., vol. 3, no. 1, p. 19.

### Genus Typhlosyrinx Thiele, 1925

Type: *Leucosyrinx vepallida* von Martens, 1902

Three species appear almost certainly congeneric—*Pleurotoma* (*Surcula*) *praecipua* E. A. Smith, 1899, *Surcula supracostata* Schepman, 1913 and *Leucosyrinx vepallida* von Martens, 1902. What is not so clearly indicated is their subfamily location.

Noticeable features of these shells are the tall spire, truncated body-whorl, sudden obsolescence of the axials over the last two whorls, low-set peripheral nodes and sigmoid outer lip profile.

The most completely known species of the group is *vepallida*. Martens described the protoconch as having the first whorl globose and smooth and figured the radula, which is typical toxoglossid, consisting of a single marginal on each side, the individual teeth being slender and barbed at the tip, exactly as in *Conus*. The operculum was stated to be absent. The sinus is

not typical daphnellid “reversed L-shape”, but tends towards that of *Turricula*.

To summarise, the daphnellid features are the slender barbed toxoglossid marginals of the radula and the absence of an operculum. Discordant features are the smooth globose protoconch and the turriculid style posterior sinus.

The absence of a daphnellid sinusigerid diagonally-cancellated protoconch coupled with an atypical sinus has decided provisional location of *Typhlosyrinx* in the Turriculinae.

Barnard (1963, Ann. S. African Mus., vol. 46, pp. 423-426) provisionally ascribed three new species of deep-water South African shells to *Typhlosyrinx*:—*pyrropelex*, *chrysopelex* and *subrosea*. All three have a characteristic daphnellid, diagonally-cancellated, 3½-4 whorled protoconch, and dagger-like, barbed tipped marginal radula teeth. All lack an operculum.

Unfortunately protoconch details are unavailable for either *praecipua* (E. A. Smith) or *supracostata* (Schepman), but combined with *vepallida* (von Martens), all three have an adult characteristic foreign to Barnard's species and that is sagged whorls with low set peripheral axials, which become obsolete over the last two whorls.

### Synonymy—

1925 *Typhlosyrinx* Thiele, Gast. Deutsch. Tiefsee-Exped., vol. 17, no. 2, p. 218; as a subgenus of *Pleurotomella*. Type by original designation: *Pleurotoma* (*Leucosyrinx*) *vepallida* von Martens, 1902.

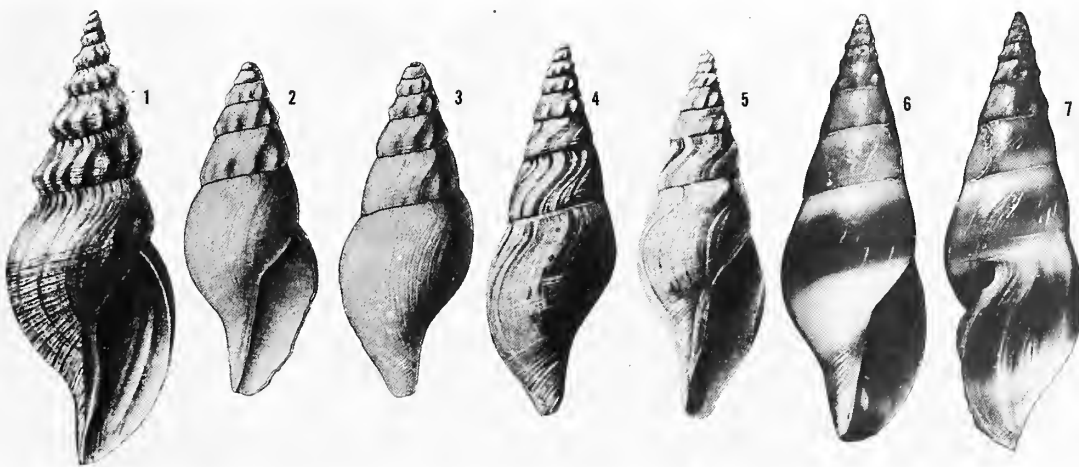


Plate 272. Fig. 1, *Typhlosyrinx vepallida* (von Martens). Gulf of Aden, 1840 metres. 44.0 mm. (from von Martens, 1903, pl. 2, fig. 6). Figs. 2, 3, *Typhlosyrinx praecipua* (E. A. Smith). India, off Tranvancore coast, 360 fathoms. 38.0 mm. (from Annandale & Stewart, 1909, pl. 9, figs. 5, 5a). Figs.

4-7, *Typhlosyrinx supracostata* (Schepman). Figs. 4, 5, Flores Sea, 794 metres, holotype. 32.0 mm. (from Schepman, 1913, pl. 27, figs. 8a, b). Figs. 6, 7, off Silungan Island, 305 fathoms, Borneo. 35.0 mm.



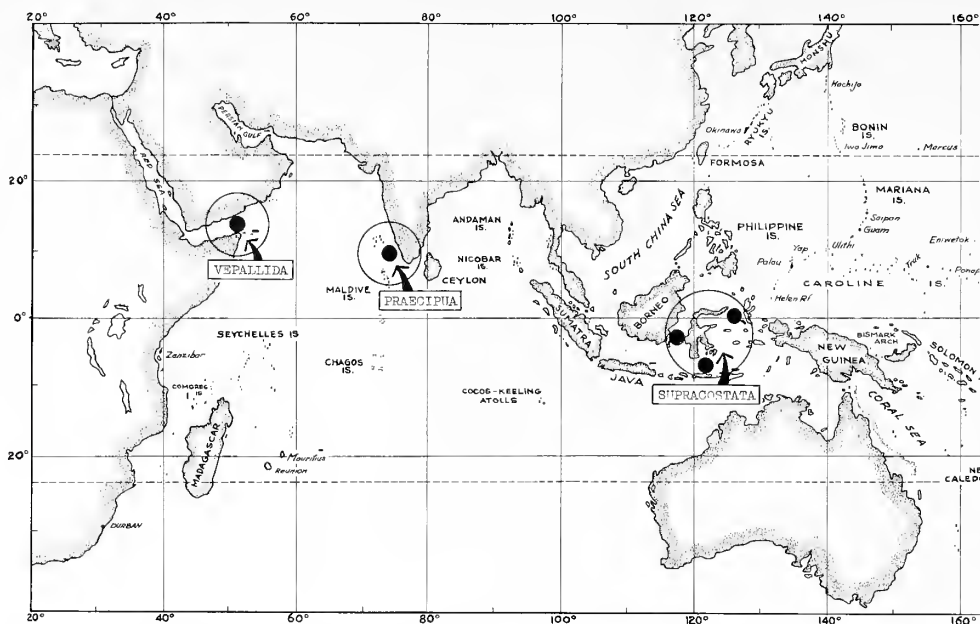


Plate 273. Geographical distribution of *Typhlosyrinx praecipua* (E. A. Smith), *supracostata* (Schepman) and *vepallida* (von Martens).

*Measurements (mm.)—*

height	width
44.0	18.0

*Synonymy—*

- 1902 *Pleurotoma (Leucosyrinx) vepallida* von Martens, Sitzungsberichte d. Gesell. nat. Freunde, Berlin, p. 240.  
 1903 *Leucosyrinx vepallida* Martens, Wissenschaft. Ergebn. deutschen Tiefsee-Exped., Gast, vol. 7, p. 89, pl. 2, fig. 6.  
 1925 *Pleurotomella (Typhlosyrinx) vepallida* (von Martens), Thiele, Wissenschaft. Ergebn. deutschen Tiefsee-Exped., vol. 17, Gastr. 2, p. 218.  
*Records—*GULF OF ADEN: 1840 metres (type locality); 14° 36' 06"N., 51° 00' 18"E., 1270 metres. Sta. 184. (John Murray Exped., Brit. Mus.)

***Typhlosyrinx vepallida* (von Martens, 1902)**

(Pl. 272, fig. 1)

*Range*—Gulf of Aden, 1270 to 1840 metres.

*Description*—Shell of moderate size, 44 mm. (1¾ inches) in height, ovate to elongate-fusiform, with tall turreted spire and short anterior end. Whorls 8½ of which the protoconch is globose and smooth, followed by a second subcylindrical whorl. Post nuclear sculpture of flexuous axials, about 12 per whorl, which suddenly thicken and become tuberculate, collectively forming a rather prominent carina just above the lower suture. Axials obsolete over the body-whorl which becomes somewhat inflated and non carinate. Aperture lunate, gradually contracted to a very short open anterior canal. Sinus broad and shallowly arcuate, sutural and confluent below with a considerable forward projection of the outer lip, the whole of which forms a regular sigmoid labial profile. Surface smooth and glossy except for irregular thin axial folds, most noticeable just below the suture, where they define successive positions of the arcuate sinus, and weak spiral lirae between the nodes and over the base, becoming stronger towards the anterior end. Colour porcellaneous white.

***Typhlosyrinx praecipua* (E. A. Smith, 1899)**

(Pl. 272, figs. 2, 3)

*Range*—INDIA, off Travancore coast, 360 fathoms.

*Remarks*—This species is undoubtedly closely allied to *Surcula supracostata* Schepman, 1913 from the Flores Sea in 794 metres. It differs from that species only in having a shorter spire and the absence of basal spirals.

*Description*—Shell of moderate size, 38 mm. (1½ inches) in height, fusiform-ovate, with spire and aperture plus canal of equal height. Rather thin, white. Protoconch missing; post-nuclear whorls 6, upper whorls sculptured with distant

strong very oblique flexuous short axials, well developed only over the lower third of whorl height where they become almost nodular. These axials are about 8 per whorl, but they suddenly become obsolete just beyond the middle of the penultimate, the remaining whorls being smooth, regularly convex and slightly inflated over the last half-whorl.

*Measurements (mm.)—*

height	width
38.0	15.0

*Synonymy—*

1899 *Pleurotoma (Surcula) praecipua* E. A. Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 4, p. 239.

1909 *Pleurotoma (Surcula) praecipua* E. A. Smith, Annandale & Stewart, Illustr. Zool. Investigator, Calcutta, Moll., vol. 6, pl. 9, figs. 5, 5a.

*Types*—The holotype is in the Indian Museum, Calcutta.

**Typhlosyrinx supracostata (Schepman, 1913)**

(Pl. 272, figs. 4-7)

*Range*—Indonesia, Borneo and Flores Sea, 305 to 417 fathoms.

*Remarks*—This species differs from *praecipua* only in being more slender, with a proportionately taller spire and the presence of distinct spiral striations on the neck and anterior end.

*Description*—(original)—“Shell fusiform, 32-46 mm. (1¼-1¾ inches) in height with short canal, thin, shining, light yellowish-white. Nucleus wanting, remaining whorls 8 nearly regularly convex, very slightly excavated below the conspicuous but shallow suture in lower whorls, more so in upper ones. Sculpture consisting in

the upper whorls of thick axial ribs, disappearing on the sixth whorl, which is 9-ribbed, the lower whorls are nearly smooth, but are sculptured under the lens by fine, strongly waved growth lines, more conspicuous at regular intervals; the whole shell crossed by very faint spirals, scarcely visible on the upper parts of whorls, stronger on the lower part, having the appearance of crowded lirae on the canal. Last whorl regularly attenuated below, ending in a short, wide canal. Aperture elongately oval, angular above, peristome with a wide but shallow sinus at the suture, then strongly protracted; columellar margin nearly straight, covered by a thin layer of enamel”.

On the basis of “Albatross” material, in the United States National Museum from 305 fathoms off Borneo, a fresh specimen shows a colour pattern of porcellaneous-white, with a broad zone of pale orange-brown, occupying most of the penultimate and body-whorl except for a moderately wide subsutural band, and a narrow second zone encircling the anterior end. The upper whorls are devoid of colour zones.

*Measurements (mm.)—*

height	width	
32.0	11.0	holotype
35.0	12.0	Silungan Id., 305 fathoms
45.0	14.8	Sibuko Bay, 415 fathoms
46.8	15.0	Molucca Passage, 417 fathoms.

*Synonymy—*

1913 *Surcula supracostata* Schepman, Siboga Exped., monogr. 49e, pt. 5, p. 422, pl. 27, fig. 8.

*Records*—INDONESIA: Flores Sea, 794 metres (type locality); off March Island, Molucca Passage, 417 fathoms (Albatross Sta. 5618, USNM). Borneo: south of Silungan Island, Sibuko Bay, 503 fathoms (Albatross Sta. 5592, USNM); N. W. of Sipadan Island, Sibuko Bay, 415 fathoms (Albatross Sta. 5587, USNM).

Genus *Belaturricula* Powell, 1951Type: *Bela turrita* Strebel, 1908

This genus was provided for a single species from off South Georgia in 160 metres. It is illustrated here on plate 274, fig. 1. No living specimens have been taken but the shell is large, 50 mm. (2 inches) in height, and narrowly fusiform with a tall spire, a large bluntly rounded, paucispiral, smooth protoconch, a short straight spout-like anterior canal and a very shallow turriculid style of posterior sinus, with the outer lip very little produced and parallel to the axis of the shell.

A very similar species, which is probably congeneric, is *Pleurotoma (Surcula) dissimilis* Watson, 1886, from 500 fathoms off the Philippines. Also recorded by Barnard (1958, Ann. S. African Mus., 44, p. 147) from off Cape Point, 660-900 fathoms, South Africa, but I am unable to verify this claim.

*Synonymy*—

1951 *Belaturricula* Powell, Discovery Reports, vol. 26, p. 170. Type by original designation: *Bela turrita* Strebel, 1908, Gast. Schwed. Sudpolar-Exped., vol. 6, p. 18, pl. 3, figs. 32a-c.



Plate 274. Fig. 1, *Belaturricula turrita* (Strebel). Off Cumberland Bay, South Georgia, 160 metres. 50.0 mm. (type of genus). Fig. 2, *Belaturricula dissimilis* (Watson). 500 fathoms, southeast of the Philippines. About 68 mm. Holotype.

*Belaturricula dissimilis* (Watson, 1886)

(Pl. 274, fig. 2)

*Range*—South east of the Philippines, 500 fathoms.

*Remarks*—This is a tentative correlation only, since the unique holotype is a dead shell, minus the protoconch. The shell, however, is remarkably similar to the South Georgian type of the genus.

Watson (below) referred to the sinus of this species as broad, open and deep but the outer lip is irregularly broken and gives no indication of the form of the sinus, which must be adduced from earlier growth lines, and these indicate a shallow sinus comparable with that of *turrita*.

*Description*—(original) "Shell large, long, fusiform, very finely striated, white, with rounded whorls, a very slightly impressed suture, a tall spire, a long unconstricted base, and a small snout. Sculpture: the surface, which is smooth and subglossy, is scored all over with fine hair-like lines of growth, of which a few at irregular intervals are slightly stronger than the rest. Spirals—these are very many feeble, narrow, irregular, subinterrupted threadlets, parted by almost obsolete furrows; they are a little stronger on the base, and weaker on the sinus region below the suture; on the back of the snout are 2 or 3 a little stronger than the rest. Colour yellowish ivory white. Spire high but solid, conical. Apex eroded. Whorls 7 remaining, convex from a very slight contraction towards both the upper and lower suture; there is besides a very faint approach to a carination in the middle of each whorl; they are of rapid but regular increase; the last one is long and a very little tumid; contracting on the base very gradually to the one-sided longish, smallish, pointed snout. Suture fine but well marked, oblique. Mouth a very long and narrow oval, pointed above and below, oblique. Outer lip thin, regularly curved. The sinus is very broad, open and deep, and lies quite up to the suture. Inner lip: a very thin glaze spreads narrowly on the body; it is concave in form throughout; round the base of the pillar there is a very slight tumidity, the front of the pillar there is a very slight tumidity, the front of the pillar is twisted and fined away with a rounded and slightly prominent edge. H. 2. 65 in. B. 0.87."

*Synonymy*—

1886 *Pleurotoma (Surcula) dissimilis* Watson, Challenger Zoology, vol. 15, p. 298, pl. 26, fig. 3.

*Types*—The holotype is in the British Museum (Natural History).



### Genus *Clavosurcula* Schepman, 1913

Type: *Clavosurcula sibogae* Schepman, 1913

A pyriform, thin-shelled, moderately large shell (38 mm.), with a smooth paucispiral protoconch, a turriculid style of posterior sinus, moderately deep, arcuate and occupying the entire shoulder slope, from the suture to the sharp peripheral carina, a thin protractively arcuately produced outer lip, and a long, straight, unnotched anterior canal. Animal and operculum unknown.

#### *Synonymy*—

1913 *Clavosurcula* Schepman, Siboga Expedition, monogr. 49e, pt. 5, p. 429. Type by original designation: *Clavosurcula sibogae* Schepman, 1913.

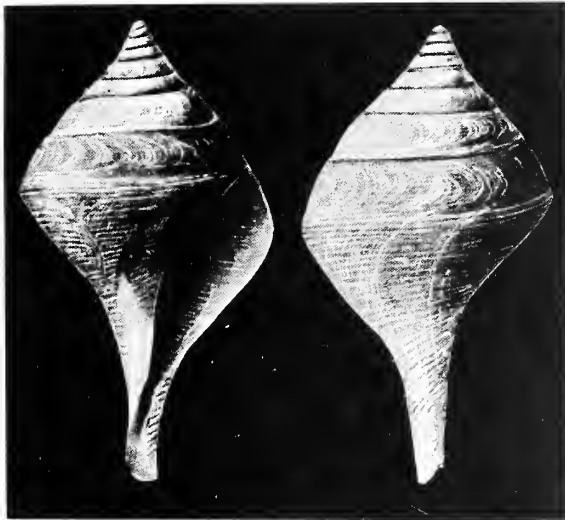


Plate 275. *Clavosurcula sibogae* Schepman. 794 metres, Flores Sea, Indonesia. 38.0 mm. (from Schepman, 1913, pl. 28, fig. 7).

### *Clavosurcula sibogae* Schepman, 1913

(Pl. 275)

*Range*—Known only from Flores Sea, Indonesia, 794 metres.

*Description*—(original) “Shell clavate, with convex spire, attenuated towards the apex, with long, slender canal, thin, pellucid, white. Whorls 8, of which about  $1\frac{1}{2}$  form a smooth, swollen nucleus, post-nuclear whorls keeled, the keel running in the 2 uppermost post-nuclear whorls a trifle above the linear suture, in the following whorls it is coalescing with the suture, on the last whorl it has the appearance of a blunt, rounded rib, with a slight groove above it; the upper whorls are nearly straight, the last 2 ones slightly convex, last whorl rapidly contracted below the keel. Sculpture consisting of numerous raised spiral striae, rather fine in upper part of whorls, very fine on a narrow zone just above the keel, coarser on the keel, much coarser on the basal part of last whorl and on the canal, which is long and slender. Aperture rhomboid, with a moderately sharp angle above and an obtuse angle at the keel; peristome thin, broken, according to growth-lines with a wide, deep sinus above, then strongly protracted. Columellar margin nearly straight above, along the body-whorl, then concave, upper part at the canal straight, then strongly contorted to the left, with a thin layer of enamel, stronger at upper part of canal; interior of aperture smooth, but apparently striated by the transparency of the shell.”

#### *Measurements* (mm.)—

height	width	
38.0	20.0	holotype

#### *Synonymy*—

1913 *Clavosurcula sibogae* Schepman, Siboga Exped., Monogr. 49e, pt. 5, p. 429, pl. 28, fig. 7.

*Records*—INDONESIA: Flores Sea, 7° 24'S., 118° 15.2'E., 794 metres, fine grey mud with some radiolariae and diatoms (type, unique).

**Genus *Austrocarina* Laseron, 1954**Type: *Leucosyrinx recta* Hedley, 1903

This monotypic genus is very distinctive, but its relationships are obscure. The shell is small, thin, pagodiform, with a strong sharp median carina on the spire whorls and the addition of a second equally strong carina on the base, which is truncated and excavated. The protoconch is exsert, white, of two smooth whorls, and the posterior sinus is very poorly developed; just a broad very shallow concavity, occupying all of the shoulder slope.

Laseron (1954, *The N. S. W. Turridae*, p. 22) assigned his genus temporarily to the *Borsoniinae*. However, since there are no traces of pillar plications, the *Turriculinae* is preferred, but again as a temporary measure.

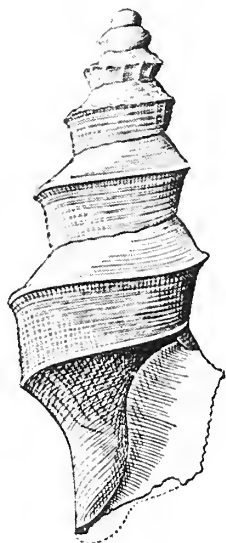


Plate 276. *Austrocarina recta* (Hedley). 63-75 fathoms off Port Kembla, New South Wales, Australia. 6.0 mm. (from Hedley, 1903, p. 386, fig. 99).

***Austrocarina recta* (Hedley, 1903)**

(Pl. 276)

*Range*—New South Wales, Tasmania and Victoria, 30-75 fathoms.

*Description*—(original) “Shell pagodiform, thin, tall and narrow. The last whorl has a median cylindrical area, angled above and below. The keel along the lower angle is buried by the suture of the following whorl; that along the upper angle projects more and ascends the spire to the protoconch, where it suddenly ceases. Above the upper keel the whorl slopes to the suture, below the lower the base is concavely excavated. Colour pale yellow. Whorls four, plus the protoconch, wound obliquely. Sculpture: the topmost whorl is undulated by about sixteen broad radial ribs, which disappear on the next whorl. Fine and coarse spiral threads alternate over the whole surface, and are crossed by fine growth lines. Protoconch exsert, white, smooth, two-whorled. Aperture broad, lip simple, no apparent sinus, canal short, open, straight.” Hedley’s type was stained; normally the shell is white.

*Measurements (mm.)—*

height	width
6.0	2.5

*Synonymy—*

1903 *Leucosyrinx recta* Hedley. *Mem. Aust. Mus.*, vol. 4, p. 386, fig. 99.

1954 *Austrocarina recta* (Hedley), Laseron, *The N. S. W. Turridae*, p. 22, pl. 4, fig. 88.

*Types*—The holotype is in the Australian Museum, Sydney.

*Records*—NEW SOUTH WALES: off Port Kembla, 63-75 fathoms (type locality); off Cape Three Points, 41-50 fathoms; off Port Hacking, 22-36 fathoms; off Botany Bay, 50-52 fathoms (Hedley, 1903); off Crookhaven, 30-35 fathoms (Laseron, 1954). TASMANIA: 50-80 fathoms (May, 1923). VICTORIA: off Ninety Mile Beach (Macpherson & Gabriel, 1962).

### Genus *Marshallena* Allan, 1926

Type: *Marshallena neozelanica* (Suter, 1917)

Kuroda (1958) named and figured a Japanese shell as *Sugitania reticulata*, new genus and new species, and later, (1959), renamed the genus *Sugitanitoma*, since his first proposition was pre-occupied in insecta by Matsumura (1926). Kuroda drew attention to the close similarity between his *reticulata* and three East Indian-Indonesian deep-water species:—*Surcula nierstraszi* Schepman, 1913, *Pleurotoma* (*Surcula*) *nereis* E. A. Smith, 1906, and *Trophon floresianus* Schepman, 1913.

Without doubt these shells are congeneric, and despite the very weak sinus, on the shoulder slope, are turrids, as shown by the “wishbone-type” radula figured by Schepman (*nierstraszi*), and this style of radula seems to be exclusive to the Turrinae and the Turriculinae. These shells also have an operculum that is very thin, ovate, with a near terminal nucleus that incurves toward the pillar.

Later, Habe (1964), claimed that *Sugitanitoma reticulata* was a synonym of Watson's *Fusus* (*Metula*) *philippinarum*, which seems to be the case, and the present writer would add, that *nereis* also, must fall as a synonym of Watson's species.

A further correlation brings in the New Zealand Tertiary genus *Marshallena*, which has a range of from middle Eocene to lower Pliocene. The type species, *neozelanica*, is so close to *nierstraszi* in general facies, including the style of protoconch, that generic identity is confidently claimed.

Another matter concerns the subfamily location of these shells, for in 1942 I placed *Marshallena*, along with *Marshallaria*, *Austrotoma*, *Vexitomina* and *Notogenota* in the subfamily Conorbiinae. I now consider that the Conorbiinae should be restricted to the genera *Conorbis* and *Cryptoconus*, both of which are much more *Conus*-like, and have a relatively deep sutural sinus.

A number of genera previously aligned with the conorbids now require re-assigning and the following, in addition to *Marshallena* and the closely allied *Marshallaria*, fit more naturally into the Turriculinae. They are *Austrotoma* Finlay, 1924, Paleocene to lower Pliocene, New Zealand and lower Miocene, Australia; *Belatoumina* Powell, 1942, Miocene, Australia and Tasmania; *Belophos* Cossmann, 1901, lower Miocene, Tasmania and Victoria; *Liratomina* Powell, 1942, Miocene to middle Pliocene, Tasmania and southern Australia and *Megasurcula* Casey, 1904, Pliocene and Recent, California and Japan. It is worthy of note that the radula of *Megasurcula carpenteriana* (Gabb) is of the modified “wishbone-type” and the operculum is leaf-shaped with a terminal nucleus. The European Tertiary *Acamptogenotia* Rovereto, 1899 (= *Pseudotonia*), also, probably belongs with the above group.

The European—North American genus *Surculites* Conrad, 1865, may represent a near prototypic turriculid, but on the other hand, Wrigley (1939) considered the genus to occupy a “not too determinate position between the Fusinidae and the Buccinidae, rather than with the Turridae.”

Still another problem is *Hormospira* Berry, 1958, whose type is *Pleurotoma maculosa* Sowerby, 1834 (Gulf of California to Ecuador). Superficially this is a typical turriculid, but the radula is atypical.

Another genus with this style of radula is typified by the Californian *Pseudomelatoma penicillata* (Carpenter, 1865), but the shell is of clavinid form. Possibly a new subfamily is required for these two genera but until the anatomy of both is known they are better retained, *sensu lato*, in the Turriculinae.

Since the above was written, J. P. E. Morrison (Annual Report of the American Malacological Union for 1965, p. 2) introduced a subfamily Pseudomelatominae for *Pseudomelatoma* and *Hormospira*, aligning it, upon supposed radula similarity, with the Muricidae or Thaididae, rather than with the Turridae. However, acceptance of this taxon would be premature without other anatomical evidence; especially if a poison gland is present or not.

*Marshallena* are moderate-sized shells (14–50 mm.) up to 2 inches in height, fusiform-biconic, with medially angulate or subangulate whorls and post-nuclear sculpture of closely spaced regular narrowly crested axial folds crossed by dense spiral cords or threads. There is



a slight tendency towards peripheral nodulation. Spire tabulated, subequal to height of aperture plus canal. Body-whorl full, slowly tapered to a moderately long, slightly flexed, unnotched anterior canal. Sinus weak, a broad shallow concavity occupying most of the shoulder slope. Protoconch regularly conic of 3-4 almost smooth whorls (Pl. 280, fig. 1). Operculum rather small, thin, corneous, ovate, with a terminal nucleus which incurves towards the pillar. Living shells are white covered by a thin yellowish-buff periostracum. Radula of paired simple "wishbone-shaped" marginals.

Typically, the genus is New Zealand Tertiary, with a range from the Eocene to the lower Pliocene.

The Recent distribution, four species, is deep water ranging from Japan to the Gulf of Aden at depths of between 100 and 1788 metres.

#### *Synonymy—*

- 1927 *Marshallena* Allan, Trans. N. Z. Inst., vol. 57, p. 291 (footnote). Type by original designation: *Daphnella neozelanica* Suter, 1917 = *Belophos incertus* Marshall, 1919.  
 1927 *Marshallena* Finlay, Trans. N. Z. Inst., vol. 57, p. 413. Type by original designation: *Daphnella neozelanica* Suter, 1917 (anticipated by Allan, 1927, p. 291).  
 1958 *Sugitania* Kuroda, Venus, vol. 20, pt. 2, pl. 21, fig. 15 (name and figure only). Type by monotypy: *S. reticulata* Kuroda, 1958.  
 1959 *Sugitanitoma* Kuroda, Venus, vol. 20, pl. 4, p. 333; *nom. nov.* for *Sugitania* Kuroda, 1958 (non *Sugitania* Matsumura, 1926). (*reticulata* Kuroda, described).

#### Key to the Recent species of *Marshallena*

- A. Whorls with sharp peripheral angle  
     Shell broadly fusiform  
         Axials gemmate . . . . . *diomedea* Powell, *n. sp.*  
         Axials not gemmate . . . . . *nierstraszi* (Schepman)  
     Shell narrowly fusiform  
         Axials incised by spirals . . . . *gracilispira* Powell *n. sp.*  
 B. Whorls subangulate  
     Shell narrowly fusiform . . . . . *philippinarum* (Watson)

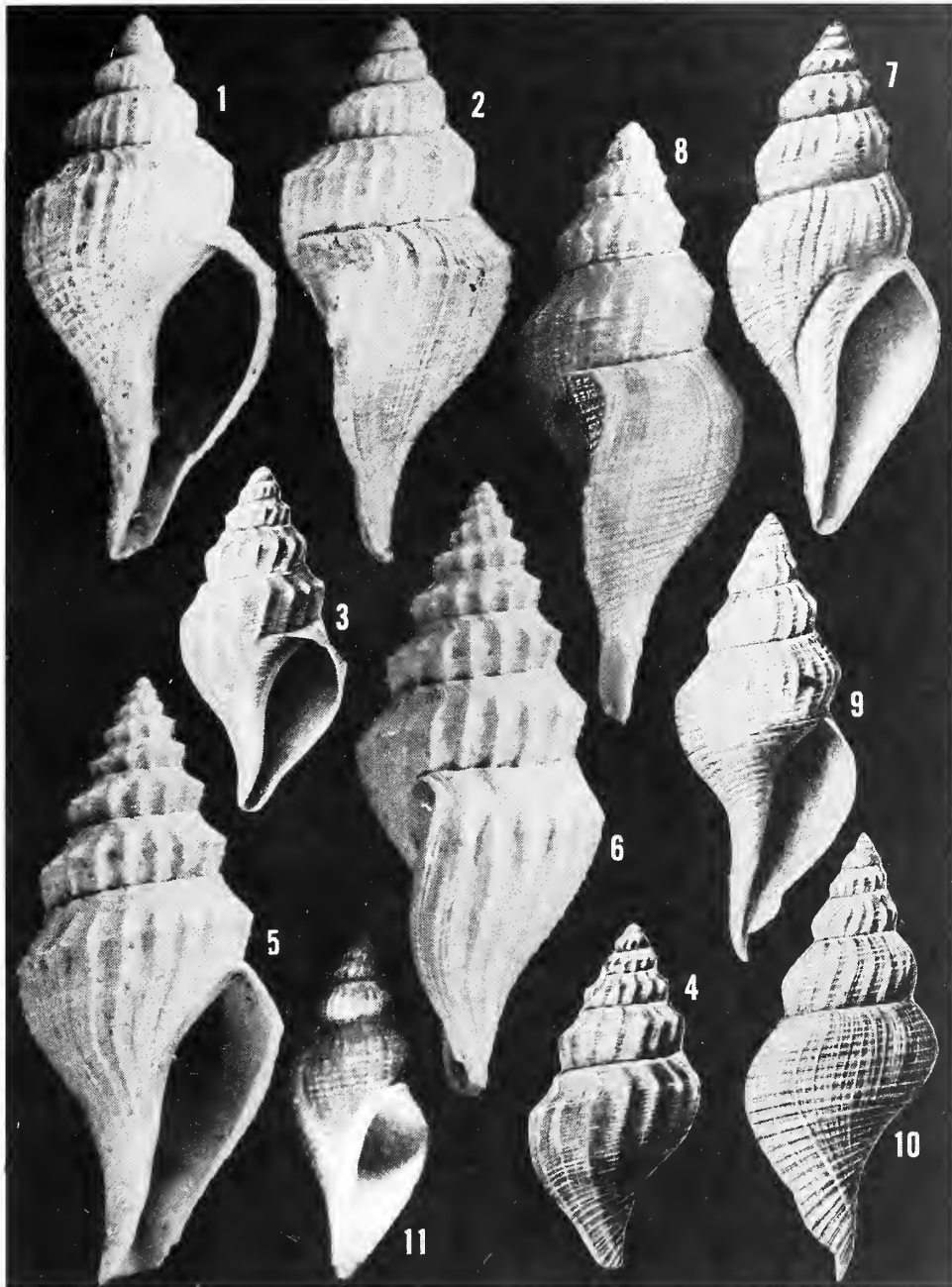


Plate 277. Figs. 1, 2, *Marshallena neozelanica* (Suter). McCullough's Bridge, New Zealand, Kaiatan, Eocene. 14.0 mm. (type of genus). Figs. 3, 4, *M. nierstraszi* (Schepman) 1788 metres, Arafura Sea. Holotype, 25.3 mm. (from Schepman, 1913, pl. 28, fig. 6). Figs. 5, 6, *M. diomedea* Powell, *new species*, 305 fathoms, Silungan Island, Borneo. Holotype, 22.0 mm. Figs. 7-11, *M. philippinarum* (Watson). Fig. 7, 569 fathoms Andaman Islands. Holotype of *nereis* E. A.

Smith. 35.0 mm. (from Annandale and Stewart, Investigator Illust., pl. 21, fig. 3. Fig. 8, Gulf of Aden. 1022 metres. 24.0 mm. Figs. 9, 10. 794 metres, Flores Sea. 18.5 mm. Holotype of *Trophon floresianus* Schepman (from Schepman, 1913, pl. 30, fig. 12. Fig. 11, 100-200 metres, Japan, holotype of *Sugitania reticulata* Kuroda, from Kuroda, 1958, Venus, 20 (2), pl. 21, fig. 15). 32.0 mm.

***Marshallena nierstraszi* (Schepman, 1913)**

(Pl. 277, figs. 3, 4; Pl. 281, fig. 1)

*Range*—Celebes and Arafura Sea in 1100-1780 metres.

*Remarks*—This species is very similar to *neozelanica* (Suter), the New Zealand Eocene type of the genus. Compared with *neozelanica*, Schepman's species differs only in having fewer, rather stronger axials with more pronounced peripheral tubercles, and a spire of equal height to that of the aperture plus the canal. In *neozelanica* the spire is considerably shorter than the aperture plus the canal.

*Description*—(original) "Shell broadly fusiform, with rather short spire, thin, greyish-white. Nucleus wanting, remaining whorls nearly 6, of which the upper one is likewise eroded, angularly convex, slightly excavated below the deep suture. Sculpture consisting of slightly oblique, narrow ribs, arcuated in the excavation, 15 in number in penultimate whorl, with blunt tubercles about the median part of upper whorls and on shoulder of last whorl, with beads at their upper extremities; just below the suture, the shell is covered with fine growth-striae and spiral lirae, these lirations being faint in the excavation, stronger and crowded in lower part of whorls, more remote on canal; last whorl attenuated below, passing without marked limit in the rather short canal. Aperture oval, slightly angular above, with a rather narrow canal below; peristome broken, according to growth-striae with a very shallow sinus below the suture; columellar margin concave above, directed to the left along the canal, with a thin layer of enamel. Operculum thin, corneous, with a terminal nucleus at the left side. Radula with 2 rows of teeth, in about 12 transverse rows, each tooth with a rather sharp point and a deep sinus at its basal margin." Operculum (Pl. 189, fig. 8). Radula (Pl. 191, fig. 2).

*Measurements (mm.)—*

height	width	
30.0	13.5	Buton Strait
25.25	12.25	holotype

*Synonymy—*

1913 *Surcula nierstraszi* Schepman, Siboga Exped., monogr. 49e, pt. 5, p. 428, pl. 28, fig. 6; radula fig. 6c.

*Types*—The holotype is in the Zoological Museum, Amsterdam.

*Records*—Arafura Sea: 5° 46.7'S., 136° 0'E., 1788 metres, bluish green mud. CELEBES, off North Island, Buton Strait, 559 fathoms (Albatross Sta. 5648).

***Marshallena diomedea*, new species Powell**

(Pl. 277, figs. 5, 6)

*Range*—Off Borneo in 305 to 310 fathoms.

*Remarks*—This species is close to *nierstraszi* in general facies. Although the spire and aperture plus canal proportions are similarly subequal, the whorls are more numerous and more tightly coiled, resulting in whorls of lesser height than in *nierstraszi*, yet the spire angle is approximately the same. The whorls are more sharply medially carinate, resulting in weak but crisp tuberculation, and all the spiral cords are weakly but distinctly gemmate at all points of intersection with the axials.

In *nierstraszi*, according to Schepman's figures and description, (and the Albatross Sta. 5648 specimen) only the peripheral carina is weakly and bluntly tuberculate and all the subsidiary spirals are non gemmate.

*Description*—Shell biconic-fusiform, ca 22 mm. (7/8 inch) in height, with spire and aperture plus canal of equal height. Whorls 7½-plus a moderately elevated broadly conical protoconch of from 3-3½ whorls, of which the last two bear weak concavely arcuate axial threads. Post-nuclear whorls medially rather sharply angulate, sculptured with narrowly crested rather flexuous axials, which are weakly developed on the upper part of the shoulder slope, are somewhat tuberculate at the peripheral carina, and continue over the body-whorl to the end of the anterior canal. There is no subsutural margining and the shoulder slope is devoid of spirals. Spiral cords, however, develop abruptly at the peripheral carina, where they render the axials weakly but crisply tuberculate. Below this all the spirals are weakly but distinctly gemmate. There are 3-4 gemmate spirals between the peripheral carina and the lower suture on the spire-whorls and about 22 on the body-whorl from below the periphery. Colour dull white.

*Measurements (mm.)—*

height	width	
22.0	9.5	holotype
13.5	6.25	off Mabul Island, 310 fathoms.

*Types*—The holotype is in the United States National Museum, Washington, no. 278974.

*Records*—BORNEO: off Silungan Island, 305 fathoms (Albatross Sta. 5592) (type locality); off Mabul Island, 310 fathoms (Albatross Sta. 5590, USNM).



**Marshallena philippinarum (Watson, 1882)**

(Pl. 277, figs. 7-11; Pl. 278)

*Range*—Philippines, East Africa, Gulf of Aden, off Andaman Islands and Flores Sea, 794-1100 metres; also Japan, 100-200 metres.

*Remarks*—This species is somewhat variable, both in the relative height of the spire, and in its sculptural development, which is often weakly to distinctly granulose at the points of intersection of the axial and spiral ribbing. It is almost certain that Schepman's *Trophon floresianus* is identical, Smith's *nereis* is definitely so, and Kuroda's Japanese *Sugitanitoma reticulata* is probably only a shallower water form of the typical species, with which it was synonymised by Habe (1964).

*Description*—Shell fusiform-biconic, 20-35 mm. ( $\frac{3}{4}$ -1½ inches) in height, thin, creamy-white, covered by a pale yellowish-buff periostracum. Whorls 4-5, plus a relatively large, broadly conic, erect protoconch of 4-4½ smooth whorls, the last half whorl with distant very fine and weak axial threads, passing into a brephic half whorl of bicarinate tubercles. The upper

band of tubercles rapidly disappear suturally but the lower one persists as a median angulation. This angulation becomes subobsolete over the last whorl. Post-nuclear sculpture of numerous slightly flexuous narrow axials which extend undiminished from suture to suture but fade out gradually over the lower base and anterior end, crossed by crisp spiral threads and cords, often weakly to distinctly granulose at the points of intersection. There are 5 or 6 spiral threads on the shoulder slope and about 5 of subcord strength, each with an intermediate thread, from the angulation to the lower suture. On the body-whorl, below the angulation, there is a fairly regular alternation of cords and threads, the cords becoming rather stronger towards the end of the canal. Spire less than height of aperture plus canal. Body-whorl rather deeply contracted over the neck, and produced anteriorly into a short slightly flexed unnotched canal. Outer lip thin and sharp, with a very shallow sinus, occupying the whole of the shoulder slope. Operculum small for the size of the aperture, thin, corneous, ovate, with a near terminal nucleus, incurved towards the pillar. Description based upon well-preserved material from the Gulf of Aden.

*Measurements (mm.)—*

height	width	
35.0	13.50	holotype of <i>nereis</i>
32.0	14.30	holotype of <i>reticulata</i>
30.0	13.00	paratype of <i>reticulata</i>
23.0	9.00	holotype of <i>philippinarum</i>
24.0	9.50	Gulf of Aden, 1061 metres
18.5	7.25	holotype of <i>floresiana</i>

*Synonymy—*

- 1882 *Fusus (Metula) philippinarum* Watson, Journ. Linn. Soc., London, vol. 16, p. 373.  
 1886 *Fusus (Metula) philippinarum* Watson, Challenger Zool., vol. 15, p. 210, pl. 12, fig. 1.  
 1906 *Pleurotoma (Surcula) nereis* E. A. Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 18, p. 161.  
 1909 *Pleurotoma (Surcula) nereis* E. A. Smith: Annandale and Stewart, Illust. Investigator Moll., pl. 21, figs. 3, 3a.  
 1913 *Trophon? floresianus* Schepman, Siboga Exped. Monogr. 49e, pt. 5, p. 452, pl. 30, fig. 12.  
 1958 *Sugitania reticulata* Kuroda, Venus, vol. 20, pt. 2, pl. 21, fig. 15 (name and figure only)  
 1959 *Sugitanitoma reticulata* (Kuroda), Venus, vol. 20, pt. 4, p. 333 (description)  
 1961 *Sugitanitoma reticulata* (Kuroda), Habe, Coloured Shells of Japan, vol. 2, pl. 40, fig. 6.  
 1964 *Sugitanitoma philippinarum* (Watson), Habe, Shells of the Western Pacific in Colour, vol. 2, p. 126, pl. 40, fig. 6.  
 1966 *Marshallena nereis* (Smith), Powell, Bull. no. 5, Auckland Mus., p. 27.

*Types*—The holotype of *philippinarum* is in the British Museum (Natural History), that of

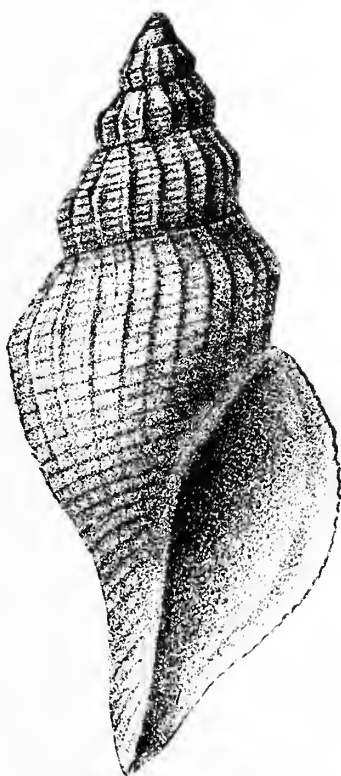


Plate 278. *Marshallena philippinarum* (Watson). 375 fathoms off the Philippines. Holotype (from Watson, 1886, Challenger Zool., 15, pl. 12, fig. 1).

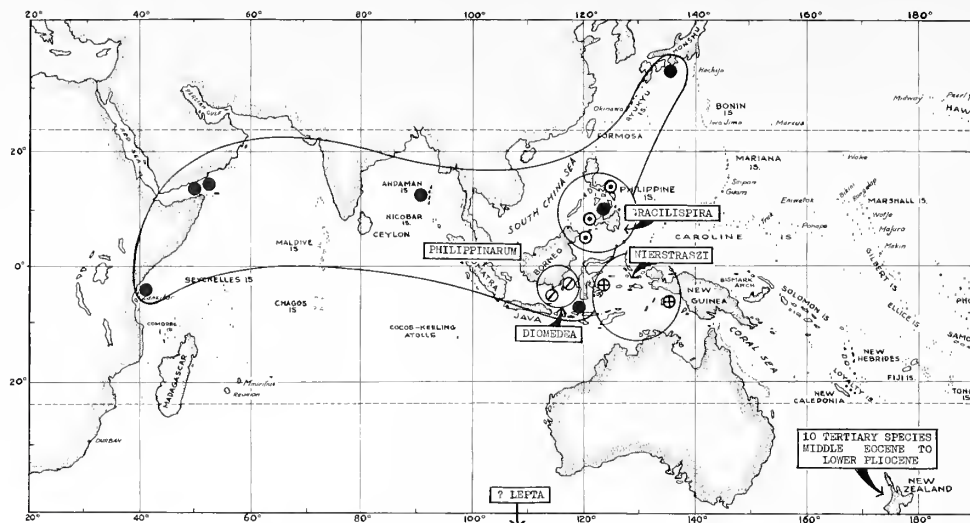


Plate 279. Geographical distribution of *Marshallena nierstraszi* (Schepman), *diomedeia* Powell, new species, *gracilispira* Powell, new species, and *philippinarum* (Watson).

*nereis* in the Indian Museum, Calcutta, and that of *floresianus* in the Zoological Museum, Amsterdam.

**Records**—PHILIPPINES: 9° 26' N., 123° 43' E., 375 fathoms (*philippinarum*), ANDAMAN ISLANDS: 569 fathoms (*nereis*); GULF OF ADEN: 13° 06' 12" N., 46° 24' 30" E., 1061 metres and 13° 05' 36" N., 46° 24' 42" E., 1022 metres. EAST AFRICA: off Pemba Island, 802 metres (John Murray Exped., Brit. Mus.); FLORES SEA: 7° 24' S., 118° 15.2' E., 794 metres (*floresiana*); JAPAN: Enshu-nada, 100-200 metres.

### *Marshallena gracilispira* new species Powell

(Pl. 281, fig. 2)

**Range**—Borneo in 305 fathoms and Philippines, 338 to 392 fathoms.

**Remarks**—This species is more closely allied to *nierstraszi* than to *diomedeia*, in that the spiral sculpture is in the form of incised lines that override the axials but do not render them gemmate; also, it is proportionately much more slender than either of the above mentioned species.

**Description**—Shell fusiform, of moderate size, 21 mm. ( $\frac{3}{4}$  inch) in height, with tall turreted spire and long straight, gradually tapered, unnotched anterior canal. Whorls 10, including a broadly conical protoconch of  $3\frac{1}{2}$  whorls, with a small erect tip; first two whorls smooth, remainder crossed by slightly concave thin axials, faint at first but strong over the last half whorl, and passing abruptly into the post-embryonic sculpture. This is of slightly oblique rather numerous axial folds, commencing abruptly as

rounded tubercles on a sharp peripheral carina, slightly above middle whorl height and overridden by incised linear grooves. Suture submargined with a rounded moderate fold, which is irregularly crenulated by axial growth lines, that continue across the otherwise smooth, moderately convex shoulder slope, and clearly mark, but somewhat irregularly, the successive positions of the broad shallowly arcuate sinus. Axials 14-15 per whorl; spiral linear grooves 3-5 on the spire whorls. The spiral grooves continue over the base but from the middle area to the anterior end they widen so that the smooth spaces between resolve into flat-topped spiral cords with subequal interspaces. Sinus distinct, broadly rounded, occupying most of the shoulder slope, its apex rather more narrowly and deeply concave than in the other species. Colour white.

### Measurements (mm.)—

height	width	
21.5	8.5	Bohol, Philippines
21.0	7.5	holotype
17.5	6.5	Tayabas Bay, Philippines.

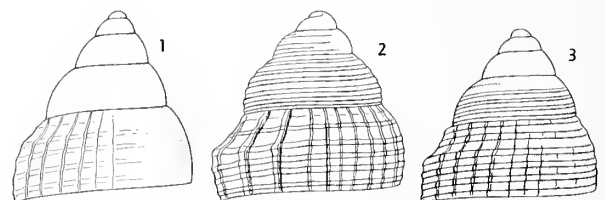


Plate 280. Protoconchs. Fig. 1, *Marshallena neozelanica* (Suter). New Zealand, Eocene. Fig. 2, *Marshallaria formosa* (Allan). New Zealand, Eocene. Fig. 3, *Austrotoma minor* (Finlay). New Zealand, Miocene.

*Types*—The holotype is in the United States National Museum, Washington (Albatross Sta. 5592, USNM 229283).

*Records*—BORNEO: south of Silungan Island, Sibuko Bay, 305 fathoms (Albatross Sta. 5592). PHILIPPINES: Tayabas Bay, Luzon, 338 fathoms (Albatross Sta. 5373). Balicasag Island, Bohol, 392 fathoms (Albatross Sta. 5527).

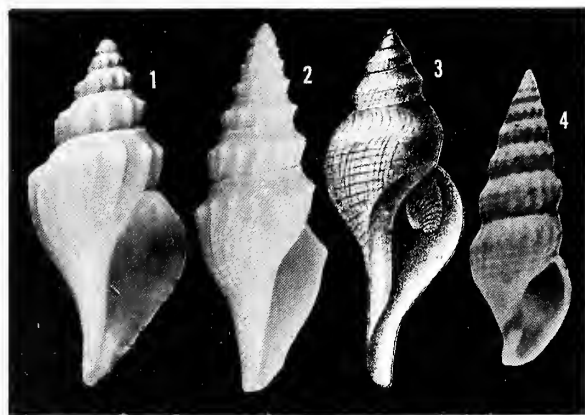


Plate 281. Fig. 1, *Marshallena nierstraszi* (Schepman). Off North Island, 559 fathoms, Celebes. 30.0 mm. Fig. 2, *Marshallena gracilispira* Powell, new species. Holotype, south of Silungan Island, Sibuko Bay, 305 fathoms, Borneo. 21.0 mm. Fig. 3, *Marshallena? lepta* (Watson). Southern Ocean, S. W. of Australia, 1950 fathoms. 38.0 mm. (from Watson, 1886, pl. 18, fig. 7). Fig. 4, *Iucaoa reticulata* Kuroda. Off Tosa, 150 fathoms, Japan. 24.5 mm. (from Habe, 1961, pl. 38, fig. 14).

### ? *Marshallena lepta* (Watson, 1881)

(Pl. 281, fig. 3)

*Range*—Southern Ocean, S. W. of Australia, 53° 55'S., 108° 35'E., 1950 fathoms.

*Remarks*—This species is referred to *Marshallena* with some doubt since the protoconch is described as smooth and mamillate of 1½ whorls. However, the figure suggests that the apical whorls have been subjected to erosion. On the other hand the general facies of the shell is in accord with *Marshallena*, as also is the operculum, which is oval, with a terminal nucleus that curves inward towards the pillar, as in *philippinarum* and *nierstraszi*.

*Description* (adapted from Watson's very full account)—Shell rather small, 1.6 inches in height, elongate-fusiform with convex subangulate whorls, thin and fragile, covered by an excessively thin pale yellow smooth periostracum. Spire about ⅔ height of aperture plus canal, the latter long, flexed and unnotched. Whorls six, including a small mamillate protoconch of 1½ whorls. Shoulder area wide, flat and steeply descending to the subangle, which is just below the middle of whorl height. Sculpture of narrow

rounded spiral cords, 5-6 from the subangle to the lower suture and continued with increasingly wider interspaces over the base. The shoulder area and the spaces between the cords are closely spirally striate. The whole surface is crossed by dense axial growth lines. The sinus is distinct, semicircular and occupies most of the shoulder area. Colour of shell, beneath the periostracum, porcellaneous and semitransparent. Operculum pale yellow, oval, nucleus terminal, incurved towards the pillar.

#### *Measurements (inches)*—

height	width	holotype
1.6	0.65	

#### *Synonymy*—

1881 *Pleurotoma (Surcula) lepta* Watson, Journ. Linn. Soc., London, vol. 15, p. 391.

1886 *Pleurotoma (Surcula) lepta* Watson, Challenger Zool., vol. 15, p. 288, pl. 18, fig. 7.

*Types*—The holotype (unique), is in the British Museum (Natural History).

### List of fossil *Marshallena* species from New Zealand

*anomala* Powell, 1942. *Marshallena*, Bull. No. 2, Auck. Inst. Mus., p. 83, pl. 14, fig. 1. Target Gully, Oamaru (Awamoan, lower Miocene).

*austrotomoides* Powell, 1931. *Marshallena*, Rec. Auck. Inst. Mus., 1, p. 106, pl. 10, figs. 5, 6. Waihi Stream, Hawera (Waitotaran, lr. Pliocene).

*carinaria* Powell, 1935. *Marshallena*, Rec. Auck. Inst. Mus., 1, p. 336, pl. 78, figs. 26, 27. Motutara, west coast, Auckland (Awamoan, lower Miocene).

*celsa* Marwick, 1931. *Marshallena*, N. Z. Geol. Surv. Pal. Bull. No. 13, p. 147, pl. 17, fig. 314. Gisborne (Tongaporutuan ? up. Miocene).

*curtata* Marwick, 1926. *Turricula*, Trans. N. Z. Inst., 56, p. 325, pl. 74, f. 8. Coast, 1 mi. S. of Wai-iti Stream, Taranaki (Tongaporutuan, up. Miocene).

*decens* Marwick, 1931. *Marshallena*, N. Z. Geol. Surv. Pal. Bull. No. 13, p. 147, pl. 17, fig. 313. Gisborne (Ormond Series, Opoitian, lr. Pliocene).



*esdailei* Marwick, 1926. *Turricula*, Trans. N. Z. Inst., 56, p. 316, pl. 72, fig. 18. Lorne, North Otago (Kaiatan, up. Eocene).

*impar* Powell, 1942. *Marshallena*, Bull. No. 2, Auck. Inst. Mus., p. 83, pl. 14, fig. 2. Takapau (N. E.) Subdivision, Dannevirke (Up. Waitotaran, lr. Pliocene).

*neozelanica* Suter, 1917. *Daphnella* (*Raphitoma*), N. Z. Geol. Surv. Pal. Bull. 5, p. 60, pl. 7, fig. 4.

"Teaneraki, Enfield", probably equals McCullough's Bridge, South Canterbury (Bortonian, Eocene). *Belophos incertus* Marshall, 1919, Trans. N. Z. Inst., 51, p. 229 is a synonym. See our plate 277, figs. 1, 2.

*serotina* Suter, 1917. *Surcula*, N. Z. Geol. Surv. Pal. Bull., 5, p. 52 (partim), pl. 6, fig. 12 only. Waihao Downs, South Canterbury (Bortonian, Eocene).

### Key to the New Zealand Tertiary species of *Marshallena*

- A. Shell small (12-21 mm.)
  - Peripheral angle sharp to carinated
    - Axials 16 per whorl, blunt, strong on base
      - Spirals 4-5 (below carina) on spire
        - ..... *curtata* (Marwick)
      - Axials 17 per whorl, blunt, rapidly diminished on base
        - Spirals 6 (below carina) on spire ... *carinaria* Powell
      - Axials 27-33 per whorl, narrow, crisp
        - Spirals 4-5 (below carina) on spire
          - ..... *neozelanica* (Suter)
  - B. Shell small to moderate sized (15-40 mm.)
    - Peripheral angle bluntly rounded
      - Axials well developed over all post-nuclear whorls
        - Spirals more prominent on base than on spire
      - Axials 13 per whorl
        - Spirals fine, subequal and numerous on spire (shoulder included); distant weak primaries on base
          - ..... *serotina* (Suter)
        - Spirals very fine and dense on spire, plus 3-4 weak primaries; basal primaries broad and strong
          - ..... *impar* Powell
      - Axials 13, decreasing to 11 per whorl
        - Spirals 3-5 primaries with 2-8 fine intermediates
          - ..... *decens* Marwick
      - Axials 17-19 per whorl
        - Spirals fine, numerous, subequal on spire-whorls
          - ..... *celsa* Marwick
      - Axials 15 per whorl
        - Spirals 4-5 on spire-whorls ..... *esdailei* (Marwick)
      - Axials very weak on spire; obsolete on last whorl
        - Spirals exceedingly fine and numerous
          - Axials 23 per whorl on spire .... *anomala* Powell
  - C. Shell large (78 mm.)
    - Spire taller than aperture, straight-sided below angle
      - Axials 14 per whorl ..... *austrotomoides* Powell

have Recent relatives in deep water, ranging from the Gulf of Aden to Japan.

#### Synonymy—

1937 *Marshallaria* Finlay & Marwick, N. Z. Geol. Surv. Pal. Bull., no. 15, p. 83. Type by original designation: *Verconella spiralis* Allan, 1926.

### Genus *Marshallaria* Finlay & Marwick, 1937

Type: *Verconella spiralis* Allan, 1926

This genus is superficially very similar to *Marshallena*, the chief differences being in a more definite regularly concave sinus and the presence of strong spiral cords on the last whorl of a dome-shaped protoconch of about  $3\frac{1}{2}$  whorls.

The genus seems to be confined to the New Zealand Tertiary with a range from the Paleocene to the upper Oligocene, but *Marshallena*, which first appears in the Bortonian, middle Eocene of New Zealand and there extends to the Wai-totaran, lower Pliocene, is claimed (above) to

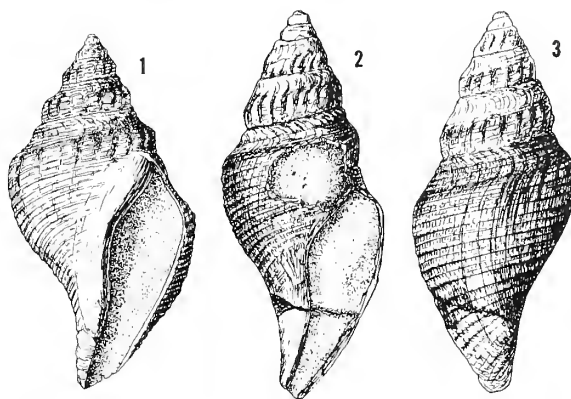


Plate 282. Figs. 1-3, *Marshallaria multincta* (Marshall). New Zealand, Boulder Hill (Wangaloan, Paleocene) (from Finlay & Marwick, 1937, pl. 11, figs. 10-12). Fig. 1 is 25.0 mm., figs. 2 and 3 are 9.0 mm.

### Key to the New Zealand Tertiary species of *Marshallaria*

Shell small (14-24 mm.)

Axials very feeble; spirals dominant

Spirals strong, linear spaced; beaded by axial threads

Shell broad..... *senilis* (Marshall and Murdoch)

Spirals wider spaced; interspaces wider than cords

Shell narrow..... *multincta* (Marshall)

Axials strong; broadly rounded

Shell narrowly fusiform

Axials 13 per whorl..... *formosa* (Allan)

Shell broadly fusiform

Axials 13 per whorl..... *uttleyi* (Allan)

Axials 19 per whorl; spirals strong..... *spiralis* (Allan)

Shell larger (30-48 mm.)

Axials 22 per whorl; not reaching upper suture but extending well over base..... *waitakiensis* Powell

Axials 15 per whorl; more or less confined to periphery..... *senta* Powell

**List of fossil *Marshallaria* species from  
New Zealand**

- formosa* Allan, 1926. *Verconella*, Trans. N. Z. Inst., vol. 56, p. 340, pl. 76, fig. 7. McCullough's Bridge, South Canterbury (Kaiatan = Tahuian, upper Eocene). (Pl. 280, fig. 2).
- multicincta* Marshall, 1917. *Daphnella*, Trans. N. Z. Inst., vol. 49, p. 457. Wangaloa, Otago (Wangaloan, Paleocene).
- senilis* Marshall & Murdoch, 1920. *Siphonalia*, Trans. N. Z. Inst., vol. 52, p. 131, pl. 6, fig. 4. Hampden, North Otago (Bortonian, mid. Eocene).
- senta* Powell, 1942. *Marshallaria*, Bull. no. 2, Auck. Inst. Mus., p. 81, pl. 14, fig. 3. Rifle Butts, Oamaru (Awamoan, lower Miocene).
- spiralis* Allan, 1926. *Verconella*, Trans. N. Z. Inst., vol. 56, p. 340, pl. 76, fig. 9. McCullough's Bridge, South Canterbury (Kaiatan = Tahuian, upper Eocene).
- uttleyi* Allan, 1926. *Verconella*, Trans. N. Z. Inst., vol. 56, p. 340, pl. 76, fig. 6. Island Sandstone, Lower Waihao River, South Canterbury (Bortonian, middle Eocene).
- waitakiensis* Powell, 1942. *Marshallaria*, Bull. no. 2, Auck. Inst. Mus., p. 81, pl. 3, fig. 11. Otiake, Waitaki River, North Otago (Waitakian, lower Miocene).



List of New Zealand Tertiary *Notogenota*

*finlayi* Powell, 1942. *Notogenota*, Bull. no. 2, Auckland Inst. Mus. p. 79. McCullough's Bridge, South Canterbury (Kaiatan, upper Eocene). Plate 283, fig. 2.

*goniodes* Suter, 1917. *Hemifusus* (*Mayeria*), N. Z. Geol. Surv. Pal. Bull. no. 5, p. 23, pl. 3, figs. 15, 16; 1917 *Surcula antegypsata* Suter, N. Z. Geol. Surv. Pal. Bull. no. 5, p. 49, pl. 6, fig. 6. Waihao River (= Waihao Downs), South Canterbury (Bortonian, lower Eocene). See our plate 283, fig. 1.

Genus *Notogenota* Powell, 1942

Type: *Notogenota goniodes* Suter, 1917

This genus has a superficial resemblance to *Genota*, but the large conical multispiral protoconch and broad shallow sinus suggest relationship in the vicinity of the genera *Marshallena* and *Marshallaria*. The type of this genus is illustrated in pl. 283, fig. 1.

Shell of moderate to large size, 30-75 mm. (1¼-3 inches) in height, with a moderately tall spire of medially strongly carinated whorls, and a long narrow body-whorl, gradually tapered to a long straight unnotched anterior canal. Protoconch large, conical, of five convex smooth whorls, with a minute styliiform tip, and weak thin axial threads developing over the last half whorl. Adult sculpture of numerous flat-topped protractively oblique axials, that extend from suture to suture, are weaker over the concave shoulder slope, and fade out over the base. The whole surface is overridden by spirals, fine threads on the shoulder slope, gradually strengthening to cord strength on the neck and anterior end. Suture slightly adpressed but only weakly margined. Aperture long and narrow; outer lip thin, with a broad shallowly concave sinus, which occupies the whole of the shoulder slope. Known only from the lower and upper Eocene of New Zealand.

*pahiensis* Powell, 1942. *Notogenota*, Bull. no. 2, Auckland Inst. Mus. p. 79, Pahi greensands, Kaipara (Bortonian, lower Eocene).

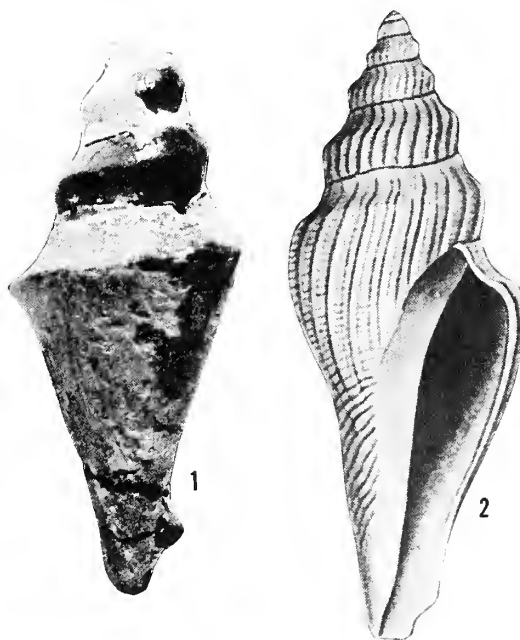


Plate 283. Fig. 1, *Notogenota goniodes* (Suter). Waihao Downs, South Canterbury, New Zealand, Bortonian, Lower Eocene (type of genus). 24 mm. (from Suter, 1917, N. Z. Geol. Surv. Pal. Bull. 5, pl. 3, fig. 16). Fig. 2, *N. finlayi* Powell. McCullough's Bridge, South Canterbury, New Zealand, Kaiatan, Upper Eocene. 32.3 mm. Holotype (from Powell, 1942, Bull. 2, Auckland Inst. Mus., pl. 3, fig. 10).

## Synonymy—

1942 *Notogenota* Powell, Bull. no. 2, Auckland Inst. Mus. p. 78.  
Type: by original designation; *Hemifusus* (*Mayeria*) *goniodes* Suter, 1917

***Iwaoa reticulata* Kuroda, 1953**

(Pl. 281, fig. 4.)

*Range*—Japan, 150 fathoms.

*Description*—(adapted from the original) Shell of moderate size, 24.5 mm. (1 inch) in height, bucciniform, with tall spire, almost twice height of aperture plus canal, and truncated base. Whorls about 11½, protoconch missing, medially rather sharply angulate. Sculptured with numerous, regular, slightly arcuate, obtuse axial plicae, about 18 on the penultimate, which gradually disappear towards the sutures, crossed by a few spiral cords, which become nodulose at the points of intersection with the axials. Spiral ribs 4-5 between sutures and 18-19 on the last whorl. The nodules at the peripheral angulation are largest and of subspinose form. Aperture with a very heavy varix on the outside of the outer lip; sinus broad and very shallow, just a slight insinuation. Parietal wall with a slight callus node. Colour pale fleshy-brown, paler near the sutures and on the base; surface smooth, without gloss. Operculum thin, yellowish-corneous, leaf-shaped with a terminal nucleus. Radula; marginals only, of modified “wishbone-type”, not severed into two components.

*Measurements* (mm.)—

height	width	
24.5	9.0	holotype

*Synonymy*—

1953 *Iwaoa reticulata* Kuroda, Venus, vol. 17, 4, p. 180, fig. 9 (radula), fig. 9a (operculum)

1961 *Iwaoa reticulata* Kuroda, Habe, Coloured Illustrations of the Shells of Japan, 2, pl. 38, fig. 14 (shell).

*Records*—JAPAN: off Tosa, 150 fathoms.

**Genus *Iwaoa* Kuroda, 1953***Type: Iwaoa reticulata* Kuroda, 1953

From the original description and Habe's coloured illustration of the type species, this genus is probably allied to *Marshallena* but has a much taller spire and a truncated anterior end, characters which recall *Paradrillia*. However the operculum is leaf-shaped with a terminal nucleus in *Iwaoa*, slightly incoiled terminally in *Marshallena* and fully clavatulid, with a medio-lateral nucleus in *Paradrillia*. From both *Marshallena* and *Paradrillia*, *Iwaoa* differs also in having a heavily variced outer lip. The radula is “wishbone-shaped” as in many members of both the Turrinae and the Turriculinae (Pl. 191, fig. 10).

*Synonymy*—

1953 *Iwaoa* Kuroda, Venus, vol. 17, 4, p. 180. Type by monotypy: *Iwaoa reticulata* Kuroda, 1953.

### Genus *Austrotoma* Finlay, 1924

Type: *Bathytoma excavata* Suter, 1917

This is the most characteristic New Zealand Tertiary turrid genus, with a range from the lower Oligocene to the lower Pliocene, and a possible occurrence as far back as the Paleocene.

Outside of New Zealand there are two lower Miocene species, one from Tasmania, the other from Victoria.

No Recent species are known, but the genus appears to be closely allied to the North Pacific *Megasurcula*, which has a Pliocene to Recent range in California and occurs also in the upper Tertiary of Japan.

The genus *Austrotoma* is of buccinid shape, with a moderately tall spire but a capacious body-whorl, which is truncated anteriorly to a very short deeply notched anterior canal, with a ridge-margined fasciole. The posterior sinus is shallow to moderate, broadly arcuate, and occupies most of the shoulder slope. The shells are of moderate to large size, 25-85 mm. (1-3¼ inches) in height. The protoconch is polygyrate of 4-5 whorls, with a minute globular tip, the first three whorls being smooth and the remainder bearing strong flat-topped spiral cords and thin axials toward its close.

It is possible that the genus may be found still living in the Austro-Neozelanic area when the archibenthic fauna is more thoroughly explored.

#### Synonymy—

1924 *Austrotoma* Finlay, Trans. N. Z. Inst., vol. 55, p. 515.

Type by original designation: *Bathytoma excavata* Suter, 1917.

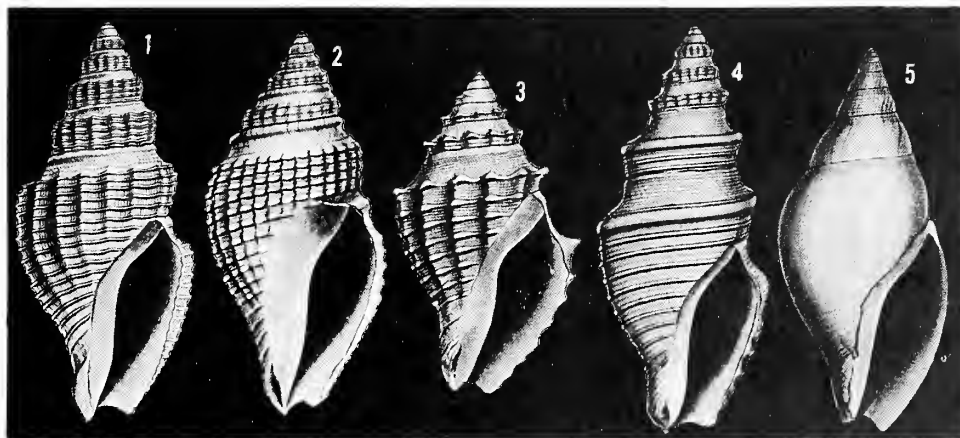


Plate 284. New Zealand *Austrotoma*. Fig. 1, *Austrotoma lawsi* Powell. Blue Cliffs, South Canterbury. 27.6 mm. Holotype (Upper Oligocene). Fig. 2, *Austrotoma gemmulata* Powell, Clifden, Southland. 31.5 mm. Holotype (Miocene). Fig. 3, *Austrotoma echinata* Powell. Clifden, Southland.

18.7 mm. Holotype (Miocene). Fig. 4, *Austrotoma kaiparaensis* Powell. Pakaurangi Point, Kaipara. 36.3 mm. Holotype (Miocene). Fig. 5, *Austrotoma cryptoconoidea* Powell. Clifden Southland. 36.3 mm. Holotype (Miocene). (from Powell, 1942, pl. 3).



**Key to the New Zealand and Australian Tertiary species of  
*Austrotoma***

- A. Subsutural fold weak to moderate  
 Spiral sculpture restricted to base  
 Axials on early spire-whorls only  
 Shoulder angle rounded  
     Subsutural fold moderate; sinus area distinct *neozelanica* (Suter)  
 Subsutural fold very weak; sinus area ill defined *cryptoconoidea* Powell  
 Shoulder angle sharp; broad smooth keel . . . . . *excavata* (Suter)  
 Spiral sculpture dominant throughout  
 Axials persistent over all whorls  
 Few, broadly rounded, strong  
     11 per whorl, extending over base . . . . . *molinei* Marwick  
     12-13 per whorl, restricted to shoulder angle . . *clifdenica* Powell  
 Axials numerous, narrowly crested  
     14-16 per whorl, extending over base . . . . . *lawsi* Powell  
     21-30 per whorl, extending over base . . . . . *toreuma* Marwick  
 Axials subobsolete over body-whorl  
     14 per whorl. Spirals narrow, weak . . . . . *eximia* (Suter)  
     16-18 per whorl. Spirals wider spaced, strong . . *minor* (Finlay)  
 Axials entirely absent from body-whorl  
     16 per whorl, Spire height less than aperture . *deducta* Marwick  
     16 per whorl. Spire height greater than aperture  
     . . . . . *inaequabilis* Marwick  
 Axials on early spire-whorls only  
 Shoulder carina rounded of 2-3 coalescent cords  
     Spirals narrow, closely spaced . . . . . *finlayi* Powell  
     Spirals broad, linear spaced . . . . . *hurupiensis* Dell  
     Spirals broad, wide spaced . . . . . *kaiparaensis* Powell  
     Spirals weak on spire, stronger on base . . . *inexpectata* Powell  
 Shoulder carina sharply angled. Whorls straight sided  
     Spirals wide spaced on base. Shell attenuated  
     . . . . . *prolixa* Laws  
     Spirals closer spaced on base. Shell normal  
     . . . . . *nervosa* Powell  
 Shoulder carina obsolete. Whorls rounded  
     Spiral cords alternating with single strong inter-  
     stitial threads. Shell very large . . . . . *ampla* Powell  
     Spiral sculpture with prickly tubercles  
     . . . . . *echinata* Powell  
 Axials entirely absent  
     Spirals strong, with interstitial threads over base  
     . . . . . *janjukiensis* Powell
- B. Subsutural fold very strong and projecting  
 Spiral sculpture dominant throughout  
     Axials obsolete . . . . . *obsoleta* Finlay  
     Axials numerous, rendering spirals gemmate  
     . . . . . *gemmulata* Powell

### List of fossil *Austrotoma* from New Zealand

- ampla* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 77, pl. 14, fig. 5. Embankment, Awatere Railway Bridge, Marlborough (Waitotaran, lower Pliocene).
- clifdenica* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 74, pl. 3, fig. 4. Clifden, 6b, Southland (Clifdenian, Miocene).
- cryptoconoidea* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 75, pl. 3, fig. 6. Clifden, E. side, B, Southland (Clifdenian, Miocene). See our plate 284, fig. 5.
- deducta* Marwick, 1931. *Austrotoma*, N. Z. Geol. Surv. Pal. Bull., 13, p. 148, pl. 17, fig. 315. Gisborne (Ormond Series, Opoitian, lower Pliocene)
- echinata* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 74, pl. 3, f. 5. Clifden, 6c, Southland (Clifdenian, Miocene). See our plate 284, fig. 3.
- excavata* Suter, 1917. *Bathytoma sulcata*, N. Z. Geol. Surv. Pal. Bull., No. 5, p. 55, pl. 6, figs. 17, 18. Lower Komiti Point Beds... Pakaurangi Point, Kaipara (Otaian, lower Miocene).
- eximia* Suter, 1917. *Bathytoma*, N. Z. Geol. Surv. Pal. Bull., No. 5, p. 54, pl. 6, fig. 15. Kyeburn, Maniototo, Otago (Waitakian, lower Miocene).
- finlayi* Powell, 1938. *Austrotoma*, Trans. Roy. Soc. N. Z., vol. 68, p. 375, pl. 39, figs. 16, 17. Near Oneroa, Waiheke Island, Auckland (Otaian, lower Miocene).
- gemmaulata* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 76, pl. 3, fig. 7. Clifden, 7c, Southland (Clifdenian, Miocene). See our plate 284, fig. 2.
- gracilicostata* Zittel, 1865. *Volnta*, Voy. Novara, Geol. 2, pt. 1, p. 38, pl. 13, fig. 6. The Cliffs, Nelson (Miocene).
- hurupiensis* Dell, 1952. *Austrotoma*, Domin. Mus. Rec. Zool. No. 8, p. 79, figs. 12, 13. Putangirua Creek, Palliser Bay (Tongaporuan, Miocene).
- inaequabilis* Marwick, 1929. *Austrotoma*, Trans. N. Z. Inst., vol. 59, pp. 922, 934, fig. 71. Chatton, Southland (Duntroonian, lower Oligocene).
- indiscreta* Finlay & Marwick, 1937. *Austrotoma*, N. Z. Geol. Surv. Pal. Bull. No. 15, p. 88, pl. 11, fig. 9. Boulder Hill, near Dunedin (Paleocene). Generic determination uncertain.
- kaiparaensis* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 73, pl. 3, f. 9. Pakaurangi Point, Kaipara (Otaian, lower Miocene). See our plate 284, fig. 4.

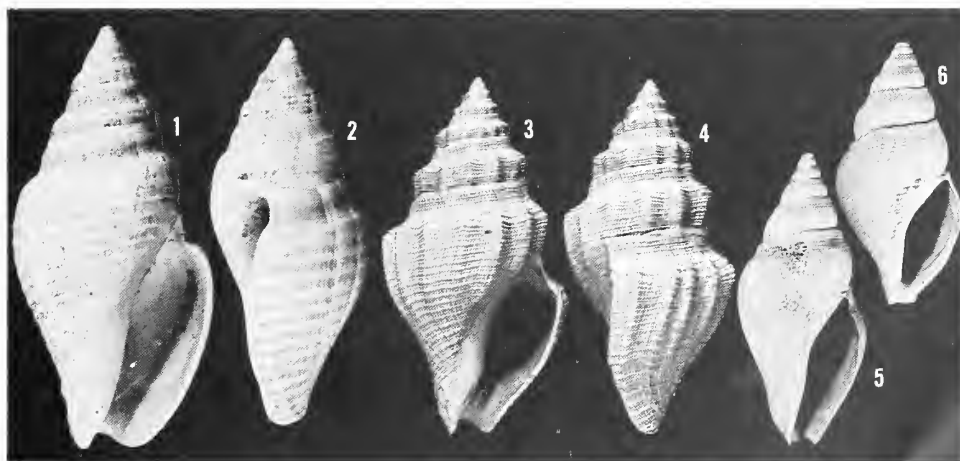


Plate 285. Fig. 1, 2, *Austrotoma minor* (Finlay). New Zealand, White Rock River, lower Miocene. 44.0 mm. Figs. 3, 4, *Belophos woodsi* (Tate). Victoria, Torquay (Oligocene). 42.0 mm. Fig. 5, *Liratomina sculptilis* (Tate). Victoria,

Muddy Creek, lower beds (Miocene). 31.0 mm. Fig. 6, *Belatomina pulchra* (Tate), Victoria, Balcombe Bay (Miocene). 28.0 mm.

- lawsi* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 75, pl. 3, fig. 8. Blue Cliffs, South Canterbury (Otaian, lower Miocene). See our plate 284, fig. 1.
- minor* Finlay, 1924. *Belophos* (*Austrotoma*), Trans. N. Z. Inst., vol. 55, p. 515; nom. nov. for *Bela? robusta* Hutton, 1877 (non Packard, 1869) = *Austrotoma scopalveus* Finlay, 1926. White Rock River, South Canterbury (Awamoan, lower Miocene) (Pl. 280, fig. 3; Pl. 285, figs. 1, 2).
- molinei* Marwick, 1931. *Austrotoma*, N. Z. Geol. Surv. Pal. Bull., No. 13, p. 148, pl. 17, fig. 316. Gisborne (Ihungia Series, Altonian, Miocene).
- neozelanica* Suter, 1913. *Clavatula* (*Perrona*), Trans. N. Z. Inst., vol. 45, p. 294, pl. 12, fig. 3 (= *Pl. sulcata* Hutton, 1873, non Lamarck, 1804 = *Bathytoma suteri* Cossmann, 1916 = *Pseudotoma huttoni* Finlay, 1924). Lower Gorge of Waipara, North Canterbury (Waiauan, Miocene).
- nervosa* Powell, 1942. *Austrotoma*, Bull. No. 2, Auck. Inst. Mus., p. 76, pl. 14, fig. 6. Mt. Harris, Canterbury (Awamoan, lower Miocene).
- obsoleta* Finlay, 1926. *Austrotoma*, Trans. N. Z. Inst., vol. 56, p. 253, pl. 55, figs. 13, 14. Lower Gorge of Waipara, North Canterbury (Waiauan, Miocene).
- prolixa* Laws, 1940. *Austrotoma*, Trans. Roy. Soc. N. Z., vol. 70, p. 55, pl. 5, fig. 9. Hawera (Waitotaran, lower Pliocene).
- toreuma* Marwick, 1929. *Austrotoma*, Trans. N. Z. Inst., vol. 59, pp. 923, 934, fig. 72. Chatton, Southland (Duntroonian, lower Oligocene).
- List of fossil *Austrotoma* from Australia**
- inexpectata* Powell, 1944. *Austrotoma*, Rec. Auck. Inst. Mus., vol. 3 (1), p. 23, pl. 7, figs. 6, 7. Tasmania, Table Cape (Langfordian, lower Miocene).
- janjukiensis* Powell, 1944. *Austrotoma*, Rec. Auck. Inst. Mus., vol. 3 (1), p. 24, pl. 3, fig. 1. Victoria, Spring Creek, upper beds (lower Miocene).



## Genus *Belophos* Cossmann, 1901

Type: *Belophos woodsi* Tate, 1888

This monotypic genus from the lower Miocene of Tasmania and Victoria is nearest allied to *Austrotoma*. It differs chiefly in the lack of a subsutural margining fold, and in the details of the protoconch, which is polygyrate, of 4-5 whorls, the tip minute, smooth and globular, the last two whorls reticulated by thin spirals and stout axials. Height 30-42 mm. ( $1\frac{1}{4}$ - $1\frac{5}{8}$  inches). For an illustration of the type species, see pl. 285, figs. 3, 4.

### Synonymy—

1901 *Belophos* Cossmann, Essais de Paléoconchologie Comparee, vol. 4, p. 162. Type by original designation: *Bela woodsi* Tate, 1888.

### List of *Belophos*

*woodsi* Tate, 1888. *Bela*, nom. nov. for *Cominella cancellata* Tenison-Woods, 1888, Trans. Roy. Soc. S. Aust., vol. 10, pp. 147, 173. Tasmania, Table Cape (lower Miocene). (Pl. 91, figs. 3, 4).

## Genus *Belatomina* Powell, 1942

Type: *Belatomina pulchra* Tate, 1888

This genus is known only from the Miocene of Tasmania and Victoria. It has a large blunt smooth protoconch of  $1\frac{1}{2}$  whorls, and the biconic to ovate adult shell is densely axially and spirally sculptured. The shoulder slope is poorly defined, the anterior canal is very weakly notched, and the sinus is broadly and shallowly arcuate. Height 20-28 mm. ( $\frac{3}{4}$ - $1\frac{1}{8}$  inches). For an illustration of the type species, see pls. 285, fig. 6 and 286, fig. 1.

### Synonymy—

1942 *Belatomina* Powell, Bull. No. 2, Auckland Institute & Museum, p. 72. Type by original designation: *Bela pulchra* Tate, 1888.

### List of *Belatomina*

*clathrata* Powell, 1944. *Belatomina*, Rec. Auck. Inst. Mus., vol. 3 (1), p. 25, pl. 7, fig. 9. Victoria, Muddy Creek, lower beds (Miocene).

*pulchra* Tate, 1888. *Bela*, Trans. Roy. Soc. S. Aust., vol. 10, p. 173. Victoria, Muddy Creek, lower beds (Miocene). (Pl. 285, fig. 6; Pl. 286, fig. 1).

*tenuisculpta* Tenison-Woods, 1877. *Daphnella*, Proc. Roy. Soc. Tasmania for 1876, p. 106. Tasmania, Table Cape (lower Miocene).

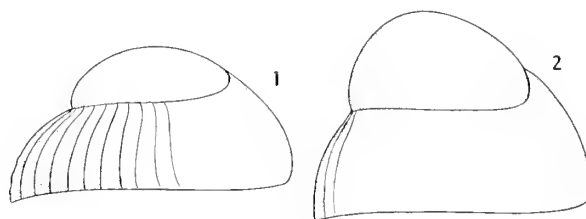


Plate 286. Protoconchs. Fig. 1, *Belatomina pulchra* (Tate). Victoria, Australia, Miocene. Fig. 2, *Liratomina sculptilis* (Tate). Victoria, Australia, Miocene.

## Genus *Liratomina* Powell, 1942

Type: *Bela sculptilis* Tate, 1888

Fusiform-turreted shells, 30-35 mm. ( $1\frac{1}{8}$ - $1\frac{1}{2}$  inches) in height, with crisp spiral and axial sculpture, the former predominant. Shoulder slope deeply concave, but no subsutural margining. Protoconch large, smooth and rounded of  $1\frac{1}{2}$  whorls. Known only from the lower Miocene of Victoria and Tasmania and the middle Pliocene of South Australia. For illustrations of the type species, see pls. 285, fig. 5 and pl. 286, fig. 2.

### Synonymy—

1942 *Liratomina* Powell, Bull. No. 2, Auckland Institute & Museum, p. 72. Type by original designation: *Bela sculptilis* Tate, 1888.

### List of *Liratomina*

*adelaidensis* Powell, 1944. *Liratomina*, Rec. Auck. Inst. Mus., vol. 3 (1), p. 27, pl. 7, fig. 5. South Australia, Abattoirs Bore, 400-500 feet, Adelaide (lower mid. Pliocene).

*crassilirata* Tate, 1888. *Bela*, Trans. Roy. Soc. S. Aust., vol. 10, p. 173, pl. 4, fig. 7. Victoria, Muddy Creek, lower beds (Miocene).

*intertexta* Powell, 1944. *Liratomina*, Rec. Auck. Inst. Mus., vol. 3 (1), p. 26, pl. 7, fig. 4. Victoria, Torquay (lower Miocene).

*sculptilis* Tate, 1888. *Bela*, Trans. Roy. Soc. S. Aust., vol. 10, p. 173. Victoria, Muddy Creek, lower beds (Miocene). See our plate 285, fig. 5.

**Genus *Acamptogenotia* Rovereto, 1899**

**Type:** *Murex (Pleurotoma) intortus* Brocchi, 1814

**Range**—Eocene to Pliocene of Europe, Oligocene of north west America and Eocene of the south eastern United States.

Shells of this genus reach a moderately large size, 40-50 mm. (1½-2 inches) in height for the type species (see pl. 287, fig. 3). They are biconic-fusiform with a capacious body-whorl which gradually tapers to a very short widely open but very shallowly notched anterior canal. The posterior sinus is broad and shallow and occupies most of the shoulder slope, which is broad and distinctly concave. Periphery medially strongly angled and axially nodose. The whole shell surface is conspicuously lirate or striate. The protoconch is of 4-4½ whorls, erect, dome-shaped, the tip flattened and planorbid, smooth except for the last whorl, which is strongly spirally ridged but without axials.

It would appear that both *Megasurcula* of Recent Californian and Tertiary Western American and North Eastern Asiatic range, as well as *Austrotoma* of New Zealand and Australian Tertiary range, are both regional marginal derivations of a formerly wide ranging *Acamptogenotia* distribution.

**Characteristic species**—European (Eocene to

Pliocene) *acuticostata* (Kautsky, 1925), *bonellii* (Bellardi, 1839), *brevispira* (Kautsky, 1925), *colpophora* (Cossmann, 1889), *connectens* (Bellardi, 1877), *escheri* (Mayer, 1861), *florae* (Hoernes & Auinger, 1878), *genei* (Bellardi, 1847), *girundica* (Peyrot, 1931), *hirsuta* (Bellardi, 1847), *idae* (Hoernes & Auinger, 1879), *intorta* (Brocchi, 1814), *laevis* (Bellardi, 1848), *loustauai* (Deshayes, 1865), *luciae* (Hoernes & Auinger, 1891), *morreni* (Koninck, 1838), *multisulcata* (Boettger, 1906), *oligocaenica* (Bellardi, 1877), *pinnata* (Bellardi, 1877), *polysarca* (Cossmann, 1896), *praecedens* (Bellardi, 1877), *quieta* (Deshayes, 1865), *semirugosa* (Bellardi, 1877), *straeleni* Glibert, 1954, *striolata* (Bellardi, 1877), *tournatella* (Boettger, 1906) and *xeniae* (Boettger, 1906). N. W. America (Oligocene) *chaneyi* (Durham, 1944). S. E. United States (Eocene): *axeli* Palmer, 1947, *floridana* Palmer, 1953 and *heilprini* (Aldrich, 1885). Mexico (Oligocene): *alazana* (Cooke, 1928).

**Synonymy—**

- 1875 *Pseudotoma* Bellardi, 1875. Bull. Soc. malac. Ital., vol. 1, p. 20.
- 1899 *Acamptogenotia* Rovereto, Atti Soc. Ligustica, 10, p. 103; nom. nov. for *Pseudotoma* Bellardi, 1875 (non *Pseudotomus* Cope, 1872).
- 1924 *Pseudotomina* Finlay, Trans. N. Z. Inst., vol. 55, p. 515; nom. nov. for *Pseudotoma* Bellardi, 1875. Type by monotypy; *Murex (Pleurotoma) intortus* Brocchi, 1814.

### Genus *Megasurcula* Casey, 1904

Type: *Pleurotoma* (*Surcula*) *carpenteriana* Gabb, 1865

Range—Recent, California, Miocene and Pliocene, California and Miocene of Korea, Japan, Washington and Ecuador.

This is a genus of large-sized shells of up to 100 mm. (4 inches) in height (see pl. 287, figs. 1, 2). They are of biconic-ovate shape, the body-whorl very capacious, shoulder area ill defined and the anterior canal very short and deeply notched, with a ridge-margined fasciole. Operculum leaf-shaped with a terminal nucleus. Radula (Pl. 191, fig. 8).

The genus seems to be nearest related to the European middle Tertiary *Acamptogenotia* (= *Pseudotoma*) but there is similarity also to the New Zealand *Austrotoma*, which differs mainly in having a subsutural fold and a better defined shoulder sulcus.

*Megasurcula* is represented in the Miocene of Korea and Japan but there do not appear to be Recent descendants in that area.

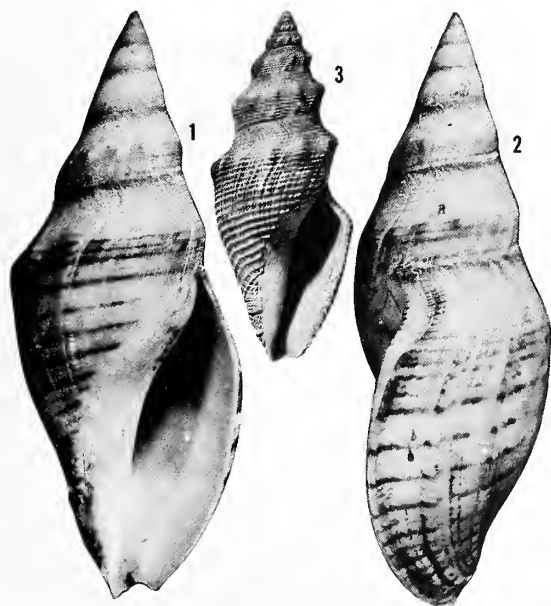


Plate 287. Figs. 1, 2, *Megasurcula carpenteriana* (Gabb). California, in deep water. 100.0 mm. Fig. 3, *Acamptogenotia intorta* (Brocchi). Astian Pliocene of Astigiana, Italy. 43.0 mm.

Characteristic species—North West America: (Miocene to Recent) *carpenteriana* (Gabb, 1865), *etheringtoni* Weaver, 1942, *fernandoana* (Arnold, 1907), *granti* Bartsch, 1944, *howei* Hanna & Hertlein, 1938, *keepi* (Arnold, 1907), *remondi* (Gabb, 1866), *riversiana* (Raymond, 1904), *tremperianus* (Dall, 1911) and *tryoniana* (Gabb, 1866). Ecuador: (Miocene) *guayasensis* Marks, 1951. KOREA: (Miocene) *cryptoconoides* (Makiyama, 1926). Japan: (Miocene) *osawanoensis* (Tsuda, 1959), *rara* (Nomura & Onisi, 1940), *siogamensis* (Nomura, 1935) and *yokoyamai* (Otuka, 1934).

### Synonymy—

1904 *Megasurcula* Casey, Trans. Acad. Sci. St. Louis, vol. 14, p. 147. Type designated by Grant & Gale, 1931, Mem. San Diego Soc. Nat. Hist., vol. 1, p. 495; *Pleurotoma* (*Surcula*) *carpenteriana* Gabb, 1865.

### Genus *Pseudomelatoma* Dall, 1918

Type: *Pleurotoma penicillata* Carpenter, 1865

Range—California to the Gulf of California, Miocene to Recent.

Although this genus has the same style of radula (see pl. 288) as *Hormospira*, the shell resembles the South African clavatulid genus *Clionella* or a clavinid. The sinus, however, is similar to that of *Hormospira* and the sculpture, typically, is of prominent subsutural nodes separated by a smooth shallow shoulder sulcus from heavy broadly rounded protractively oblique axials. The operculum is leaf-shaped with a terminal nucleus, like that of *Hormospira*. In *Clionella* the operculum has a medio-lateral nucleus.

Characteristic species—*fleenerensis* (Martin, 1914), *fulleri* Durham, 1944, *grippi* (Dall, 1919), *moesta* (Carpenter, 1864), *penicillata* (Carpenter, 1865) and subspecies *semiinflata* Grant & Gale, 1931, *somisensis* Waterfall, 1929, *stricta* Berry, 1956, *torosa* (Carpenter, 1863) and subspecies *aurantia* (Carpenter, 1863). (Pl. 288, figs. 1-3; radulae).

### Synonymy—

1918 *Pseudomelatoma* Dall, Proc. U. S. Nat. Mus., vol. 54, p. 317. Type by original designation; *Drillia penicillata* Carpenter, 1865.



### Genus *Hormospira* Berry, 1958

Type: *Pleurotoma maculosa* Sowerby, 1834

Range – Gulf of California to Ecuador.

This genus (pl. 289), along with *Pseudomelatoma*, is problematic, since although they possess a turriculid-style sinus, the radula is unlike that of any other known turrid group; in fact the radula more closely resembles that of the muricids (pl. 96, fig. 4). However until the gross anatomy of these two genera is known they are best retained provisionally as *sensu lato* mem-

bers of the Turriculinae. See previous remarks relating to Morrison's 1965 opinions under our discussion of the genus *Marshallena*.

Shell moderately large, 37-40 mm. ( $1\frac{3}{8}$ - $1\frac{5}{8}$  inches) in height, elongate fusiform, with tall and narrow turreted spire and narrow elongate aperture gradually tapered to a moderately long straight anterior canal. The sinus is moderately deep, occupying most of the shoulder slope, but its apex is rather narrowly U-shaped and situated at about the lower third. The operculum is leaf-shaped with a terminal nucleus (Pl. 288, fig. 6). A probable second member of this genus is *Turricula libya* Dall, 1919, which has the same style of radula as *maculosa*, and it is possible that *Tiariturris spectabilis* Berry, 1958 from the Gulf of California is another member of this group of genera.

#### Synonymy –

1958 *Hormospira* Berry, Leaflets in Malacology, vol. 1, no. 15, p. 90. Type by original designation; *Pleurotoma maculosa* Sowerby, 1834.

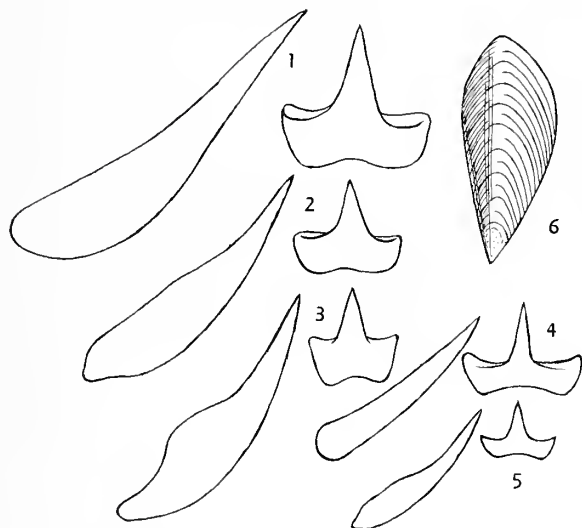


Plate 288. Radulae. Fig. 1, *Pseudomelatoma penicillata* (Carpenter). Lower California. Fig. 2, *Pseudomelatoma torosa* (Carpenter). Monterey, California. Fig. 3, *Pseudomelatoma grippi* (Dall). San Diego, California. Fig. 4, *Hormospira maculosa* (Sowerby). La Paz, West Mexico. Fig. 5, *Hormospira libya* (Dall). Lower California. Fig. 6, operculum of *Hormospira maculosa* (Sowerby). (radulae drawings prepared by J. P. E. Morrison, U. S. Nat. Mus., Washington).

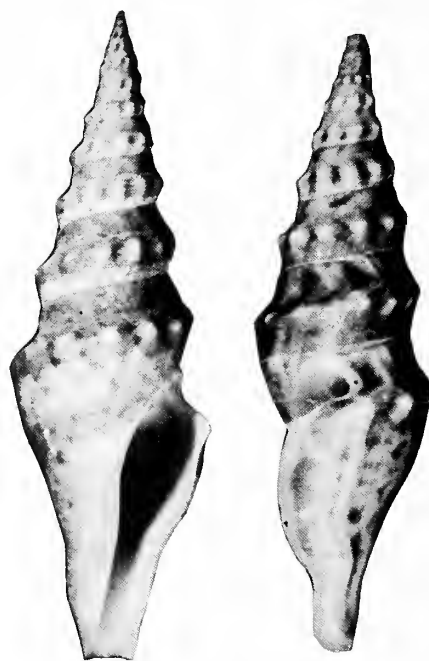


Plate 289. *Hormospira maculosa* (Sowerby). La Paz, West Mexico. 50.0 mm.

### Subgenus *Lutema* Stephenson, 1941

Type: *Amuletum (L.) simpsonensis* Stephenson, 1941

Shell (pl. 290) of moderate size, up to 30 mm. (1¼ inches) in height, similar to *Amuletum* but with stronger shouldering and peripheral nodulation. Known only from the Cretaceous Ripley formation of Texas and Mississippi.

Characteristic species—*hubbardi* Stephenson, 1941; *limbatum* Sohl, 1964; *munda* Stephenson, 1941 and *simpsonensis* Stephenson, 1941.

### Synonymy—

1941 *Lutema* Stephenson, Univ. of Texas Publ. no. 4101, p. 373. Type by original designation: *Lutema simpsonensis* Stephenson.

### Genus *Amuletum* Stephenson, 1941

Type: *Turricula macnairyensis* Wade, 1926

Small rather slender shells (pl. 290) with a spire about half total shell height. Protoconch large of 3-4 smooth whorls. Post-nuclear whorls rounded, slightly constricted on the shoulder slope, and with a moderate subsutural fold. Anterior canal long, slender, slightly flexed and unnotched. Outer lip with a shallow subsutural sinus. Spiral sculpture crossed by arcuate axials.

The genus differs from *Turricula* in its narrowly fusiform shape and in its smooth 3-4 whorled protoconch.

Range—Late Cretaceous of the southern United States.

Characteristic species—*dumasensis* Sohl, 1964, *fasciolatum* (Wade, 1926), *macnairyensis* (Wade, 1926) and subspecies *torquatum* Sohl, 1964, *wadei* Harbison, 1945.

### Synonymy—

1941 *Amuletum* Stephenson, Univ. of Texas Publ. no. 4101, p. 369. Type by original designation; *Turricula macnairyensis* Wade, 1926.

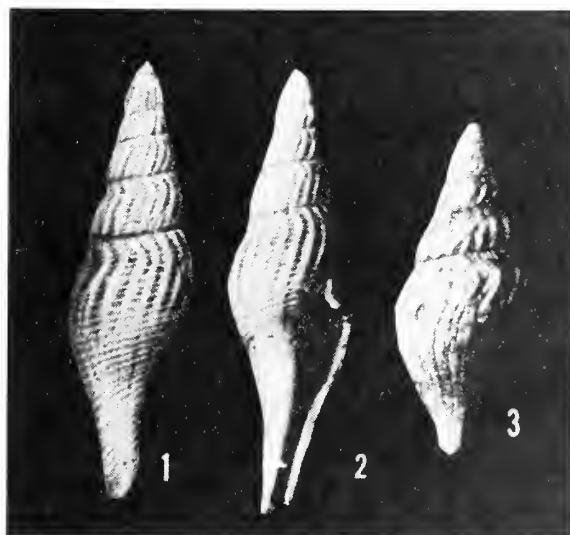


Plate 290. Figs. 1, 2, *Amuletum (Amuletum) macnairyensis* (Wade, 1926). Coon Creek, Tennessee (Cretaceous). 11.6 mm. Fig. 3, *Amuletum (Lutema) simpsonensis* (Stephenson, 1941). Texas (Cretaceous). 13.5 mm. (from Sohl, 1964, and Stephenson, 1941).

### Genus *Beretra* Stephenson, 1941

Type: *Beretra firma* Stephenson, 1941

Medium-sized, fusiform shells (pl. 291) with a high turreted spire of less than half total shell height. Sculpture of strong axial ribs that cross the narrow shoulder sulcus and become nodulose on a heavy subsutural fold. The whole crossed by closely spaced spiral threads or cords. Aperture lanceolate; anterior canal long, slender, straight and unnotched. Sinus subsutural, distinctly notched.

*Range*—Late Cretaceous of the Atlantic and Gulf coastal plains from Maryland to Texas, and an undescribed species from Montana (Sohl, 1964, p. 282).

*Characteristic species*—*amica* (Gardner, 1916), *contracta* Stephenson, 1941, *elongata* Stephenson, 1941, *firma* Stephenson, 1941, *gracilis* (Wade, 1926), *ornatula* Stephenson, 1941, *ripleyana* (Conrad, 1858) and *speciosa* Sohl, 1964.

#### *Synonymy*—

1941 *Beretra* Stephenson, Univ. of Texas Publ. No. 4101, p. 375. Type by original designation; *Beretra firma* Stephenson, 1941.

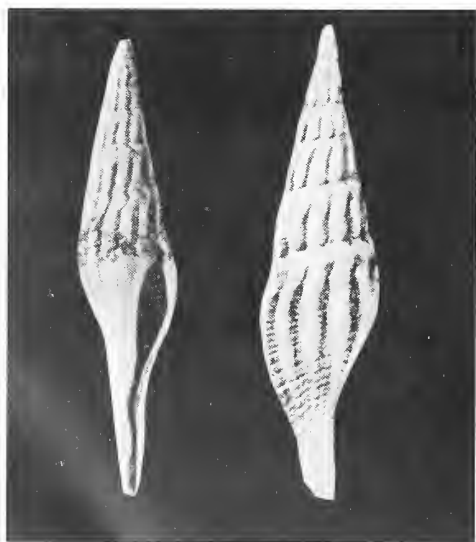


Plate 291. *Beretra gracilis* (Wade, 1926). Coon Creek, Tennessee (Cretaceous). 58.7 mm. (from Sohl, 1964, pl. 46, figs. 15, 17).

### Genus *Fusimilis* Stephenson, 1941

Type: *Fusimilis robustus* Stephenson, 1941

Medium-sized fusiform shells (pl. 292) with a turriculate spire of less than half total height. Similar to *Beretra* but with an ovate, less elongate aperture and a sinus in a lower position, coinciding with the shoulder angulation. The anterior canal is long, straight and slender. The sculpture is of strong axial ribs suddenly terminated at the shoulder, which defines a relatively deep and narrow shoulder sulcus. Subsutural fold moderate, bearing numerous axial growth folds.

*Range*—Late Cretaceous, Ripley, Owl Creek and Monmouth Formations, Atlantic and Gulf areas from Maryland to Texas. Also upper Cretaceous of West Africa (Sohl, 1964, pp. 167, 284).

*Characteristic species*—United States: *kummeli* Sohl, 1964, *monmouthensis* (Gardner, 1916), *novemcostata* (Conrad, 1858), *proxima* (Wade, 1926) *robustus* Stephenson, 1941. West Africa: *aurilotalis* Cox, 1952.

#### *Synonymy*—

1941 *Fusimilis* Stephenson, Univ. of Texas Publ. No. 4101, p. 378. Type by original designation: *Fusimilis robustus* Stephenson, 1941.

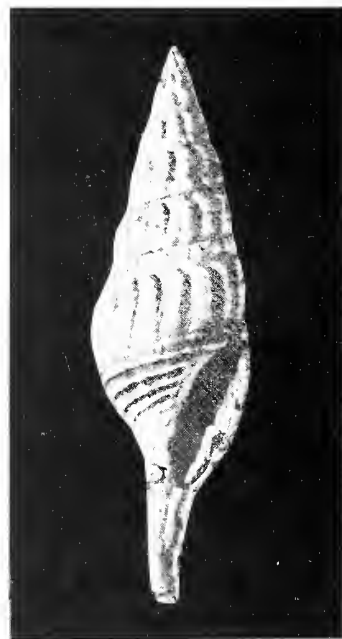


Plate 292. *Fusimilis proxima* (Wade, 1926). Tennessee (Cretaceous). 88 mm. (from Sohl, 1964, pl. 46, fig. 27).



### Genus *Remnita* Stephenson, 1941

Type: *Turricula biacuminata* Wade, 1926

Medium-sized shells (pl. 293) with a turriculate spire of less than half total height. Protoconch proportionately large, consisting of 3-4 smooth regular whorls. Subsutural margin very narrow. Sculpture initiated and dominated throughout by spiral cords.

Range—Late Cretaceous of Mississippi and Texas, confined to the *Exogyra costata* zone.

Characteristic species—*biacuminata* (Wade, 1926), *anomalocostata* (Wade, 1926) and *hastata* Sohl, 1964.

#### *Synonymy*—

1941 *Remnita* Stephenson, Univ. of Texas Publ. No. 4101, p. 378. Type by original designation: *Turricula biacuminata* Wade, 1926.

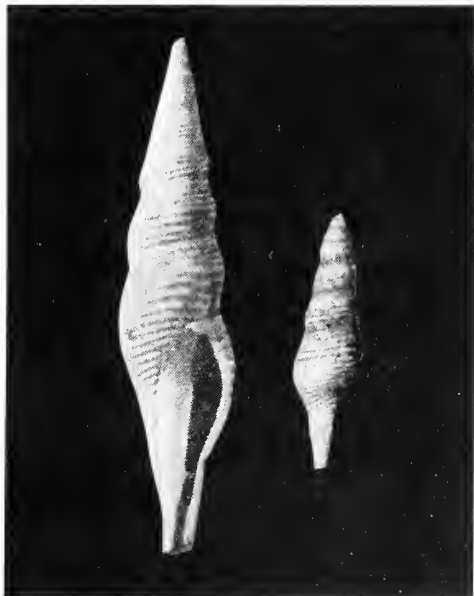


Plate 293. *Remnita biacuminata* (Wade, 1926). Tennessee (Cretaceous). 42.8 mm. (from Sohl, 1964, pl. 46, figs. 7, 8).

### Genus *Catenotoma* Cossmann & Pissarro, 1900

Type: *Surcula catenata* Lamarck, 1804

This is a monotypic genus from the Eocene of Cotentin, France. The type species (pl. 294) is 25-30 mm. (1-1¼ inches) in height, elongate-fusiform, with rather sagged whorls, sculptured with distant bold, broadly rounded axials, only 4-5 per whorl. The protoconch is smooth, globose and paucispiral.

#### *Synonymy*—

1900 *Catenotoma* Cossmann & Pissarro, Faune Éocénique du Cotentin, Bull. Soc. Géol. de Normandie, 19 (1), p. 23; as a section of *Surcula*. Type by monotypy; *Pleurotoma catenata* Lamarck, 1804.

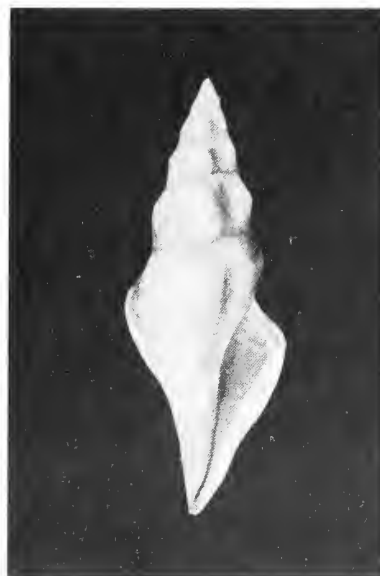


Plate 294. *Catenotoma catenata* (Lamarck, 1804). Paris Basin, France (Eocene). 36 mm.

**Genus *Fusiturricula* Woodring, 1928**

Type: *Turris (Surcula) fusinella* Dall, 1908

Shell small- to medium-sized (up to 30 mm.), narrowly-fusiform, of light build, *Fusinus*-like. Sculpture consisting of stout fold-like oblique axials, overridden by spiral cords and threads; some, including the type species, with a low-set peripheral biangulation. Anal sinus wide, moderately deep, adjoining the suture and confluent below with a great arcuate forwardly projected expansion of the outer lip, which gives the impression of great depth to the sinus. Anterior canal moderately long and straight, unemarginate at its extremity. Protoconch narrowly conic, of  $1\frac{3}{4}$  to  $2\frac{3}{4}$  smooth whorls with a small erect nucleus. The radula is illustrated in plate 191, fig. 9, the shell on plates 295 and 296.

The range of the genus is Miocene of the Caribbean and Recent from Panama to West Mexico. The genus seems to be very closely allied to the Eocene-Miocene *Pleurofusua* the type species of which is from the Claibornian Eocene of Alabama.

The chief differentiating character distinguishing *Fusiturricula* is the impression of a very deep anal sinus resulting from the greatly forwardly produced outer lip.

*Characteristic species*—Miocene: *humerosa* (Gabb, 1873); *iola* Woodring, 1928 and *panola* Woodring, 1928. Recent: *armilda* (Pl. 296, fig. 2), *dolenta* and *fusinella* (Dall, 1908) *enae* Bartsch, 1934 and *howelli* Hertlein & Strong, 1951.

The genus does not appear to be applicable to any Indo-Pacific shells, either Recent or fossil.

*Synonymy*—

1928 *Fusiturricula* Woodring, Miocene Mollusks from Bowden, Jamaica, Part 2, Carnegie Institution of Washington, Publication No. 385, p. 165. Type by original designation: *Turris (Surcula) fusinella* Dall, 1908.

**Subgenus *Crenaturricula* Vokes, 1939**

Type: *Surcula crenatospira* Cooper, 1894

This was proposed as a subgenus of *Fusiturricula* Woodring, 1928, for a Californian fossil from the Capay horizon of the Eocene, and with it was associated *Pleurotoma dentata* Lamarck, 1804 of the Lutetian Eocene of the Parisian Basin, possibly *Pleurotoma michelini* Deshayes, 1865, also of the Paris Basin and *Pleurotoma keelei* Edwards, 1856 of the English Eocene. The type is illustrated in plate 295.

Vokes remarked that "The Eocene species which appear to be referable to *Fusiturricula* are in general larger and stouter than in the later species of this genus, the anal sinus somewhat shallower and the outer lip does not project as far forward."

Glibert (1960, Mem. Inst. Roy. Sci. Nat. de Belgique, Ser. 2, 64, pp. 33-35) referred the following European fossils to *Crenaturricula*:—*bouryi* Glibert, 1960, *brevicauda* Deshayes, 1834, *crassicauda* Edwards, 1857, *dentata* Lamarck, 1804, *exorta* Solander, 1766, *hauniensis* Koenen, 1885, *macilenta* Solander, 1766, *michelini* Deshayes, 1865, *polycosta* Bayan, 1873 and *textiliosa* Deshayes, 1834. The range is Paleocene to Eocene.

This subgenus does not appear to be applicable to any Indo-Pacific shells, either Recent or fossil.

*Synonymy*—

1939 *Crenaturricula* Vokes (subgenus of *Fusiturricula* Woodring, 1928), Molluscan Faunas of the Domengine and Arro Hondo Formations of the California Eocene, Ann. New York Academy of Sciences, vol. 38, p. 114. Type by original designation: *Surcula crenatospira* Cooper, 1894, Eocene, Capay horizon, California.



Plata 295. *Fusiturricula (Crenaturricula) crenatospira* (Cooper, 1894). California (Eocene). 37 mm. (from Vokes, 1939, pl. 17 fig. 4).

### Subgenus *Fusisyrinx* Bartsch, 1934

Type: *Fusisyrinx fenimorei* Bartsch, 1934

This genus, described as very large, 56 mm. (2¼ inches) in height, of “*Fusus*-like” appearance, with the aperture of almost equal height to the rest of the shell and a strong deeply cut sinus at the summit of the whorls.

Actually the sinus is not, in its normal condition, like Bartsch’s fig. 5, which shows a deep sinus, broadly rounded at its apex on the mid shoulder slope, and then rather steeply descending in a considerable forward projection. A topotype in the MCZ., Harvard, which I now figure (Pl. 296, fig. 4) shows the normal condition of the sinus and examination of the holotype in the USNM, revealed that the lower limb of the sinus has been broken or worn away, giving rise to its present condition.

Unfortunately the nuclear whorls of *fenimorei* are unknown, but except for this fact there seems to be little to separate *Fusisyrinx* from *Fusiturricula* other than large size and a slightly longer and straighter anterior canal for the former. Until more is known concerning *Fusisyrinx* it is retained tentatively as a subgenus of *Fusiturricula*.

#### Synonymy—

1934 *Fusisyrinx* Bartsch, Smithsonian Miscellaneous Collections, vol. 91 (2), p. 7, pl. 2, figs. 4, 5. Type by original designation: *Fusisyrinx fenimorei* Bartsch, 1934, Puerto Rico Deep, 80-180 fathoms.

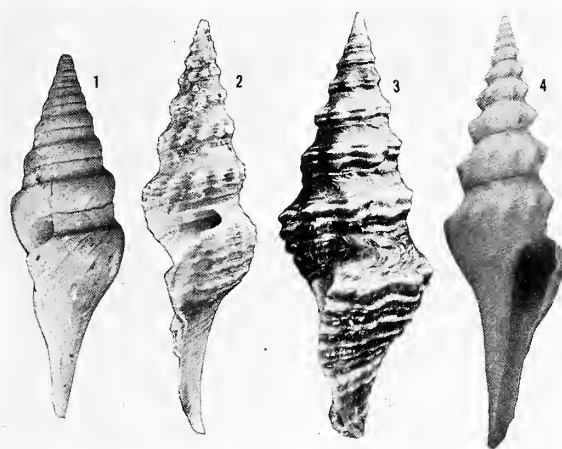


Plate 296. Fig. 1, *Orthosurcula longiforma* (Aldrich). Red Bluff, Mississippi, Vicksburg Oligocene. 50.0 mm. Fig. 2, *Fusiturricula armilda* (Dall). Gulf of California, 100-125 fathoms. 40.0 mm. Fig. 3, *Knefastia olivacea* (Sowerby). Guaymas, West Mexico. 42.0 mm. Fig. 4, *Fusisyrinx fenimorei* Bartsch. Puerto Rico Deep, 80-180 fathoms. 56.0 mm.

### Genus *Cruziturrlicula* Marks, 1951

Type: *Cruziturrlicula cruziana* Olsson, 1932

The author of this genus stated that it is most closely related to *Fusiturricula* Woodring, 1928, from which it differs mainly in having a more attenuated protoconch, and in the form of the anal sinus. The spire angle is about 20 degrees, while that of *Fusiturricula fusinella* (Dall), the type of *Fusiturricula*, appears to be over 30 degrees. *Cruziturrlicula* has a mesocostate, unicarinate early spire sculpture, while *Fusiturricula* is bicarinate. *Cruziturrlicula* has irregular axial ribs, while those of *Fusiturricula* are regular and evenly spaced. The anal sinus in *Fusiturricula* is deep, with a vertical angle with the suture. The anal sinus in *Cruziturrlicula* is a deep slot, the upper edge being a retrocurrent oblique line against the suture (adapted from the original description). The type is illustrated in plate 297.

#### Synonymy—

1951 *Cruziturrlicula* Marks, Miocene Stratigraphy and Paleontology of Southwestern Ecuador. Bull. American Paleont., Ithaca, vol. 33 no. 139, p. 131. Type by original designation: *Turricula (Pleurofusina) cruziana* Olsson, 1932.

*Characteristic species*—Lower Eocene: *eolavinia* (Olsson, 1930), Peru. Upper Eocene: *piura* (Olsson, 1931), Peru. Lower Miocene: *cruziana* (Olsson, 1932), Peru and Ecuador. Pliocene: *andesita* (Olsson, 1942), Panama and Costa Rica. Recent: *lavinia* (Dall, 1919), West Mexico. *arcuata* (Reeve, 1843). Central America. There appear to be no Indo-West Pacific members of this genus.



Plate 297. *Cruziturrlicula cruziana* (Olsson, 1932). Peru (Miocene). 25 mm. (from Olsson, 1932, pl. 8, fig. 6).



**Genus *Knefastia* Dall, 1919**Type: *Pleurotoma olivacea* Sowerby, 1834

*Range*—Recent, Gulf of California to Ecuador; Miocene and Oligocene; Washington, Costa Rica, Panama, West Colombia, Peru, Florida and San Domingo. Also recorded (but requires confirmation) from the Miocene of France, Angola and the Pliocene of Italy. (References; Glibert, 1960, Bull. Inst. Roy. Sci. Nat. Belg., 36, No. 33 and Caster, 1938, Comm. Serv. Geol. Portugal, 20).

The shells (pl. 296 fig. 3) are large, 50-70 mm. (2-2¼ inches) in height, heavy and robust, biconic-fusiform, resembling *Clavatula* in the coarseness of the sculpture and especially in the high clasping adpressed suture. The operculum is leaf-shaped with a terminal nucleus which is inclined slightly inward towards the columella. The radula is of modified wish-bone type, with the two distal extremities separated and usually there is a small vestigial unicuspid central tooth (Pl. 191, figs. 6, 7). The genus seems to combine the characteristics of both the Turriculinae and the Clavatulinae but with leanings nearer toward the former subfamily.

*Characteristic species*—Recent: *dalli* (Bartsch, 1944), *funiculata* (Kiener, 1839-40), *nigricans* Dall, 1919, *olivacea* (Sowerby, 1834), *princeps* Berry, 1953, *tuberculifera* (Broderip & Sowerby, 1829), *walkeri* Berry, 1958; Oligocene: *brooks-villensis* Mansfield, 1937, *chira* Olsson, 1931, *rossellae* Durham, 1944; Miocene: *glypta* Gardner, 1937, *jaquensis* (Sowerby, 1850), *lavinoides* Olsson, 1922 and subspecies *limonensis* Olsson, 1922, *waltonia* Gardner, 1937.

*Synonymy*—

1919 *Knefastia* Dall, Proc. U. S. Nat. Mus., vol. 56, no. 2288, p. 3. Type by original designation; *Pleurotoma olivacea* Sowerby, 1834.

**Genus *Eosurcula* Casey, 1904**Type: *Turris moorei* Gabb, 1860

Shell of medium size, 25 mm. (1 inch) in height, very slender with tall spire and long straight anterior canal and narrow elongated aperture. Sculpture spirally lirate on the steeply descending shoulder area and strongly cordate to carinate below the shoulder angulation. There is an entire absence of axial sculpture. Protoconch multispiral, narrowly elevated, smooth.

It is difficult to decide where to place this genus for it looks to be truly turriculid but is obviously not far removed from *Protosurcula*, the type species of which, *gabbii* Conrad, 1865, sometimes exhibits a distinct medial columellar plication, indicative of the Borsoniinae.

However, the problem does not concern us at the moment since there appear to be no Indo-Pacific members of these American Eocene genera. The type is illustrated in plate 298.

*Characteristic species*—(Casey, 1904). All from the Lower Claiborne Eocene of Texas and Alabama: *concinna* and *helicoidea* Casey, 1904, *moorei* (Gabb, 1860), *pulcherrima* (Heilprin, 1879) and *tuomeyi* (Aldrich, 1886). Domengine, Eocene of California: *capayana* Vokes, 1939.

*Synonymy*—

1904 *Eosurcula* Casey, 1904, Trans. Academy of Science, St. Louis, vol. 14, p. 145. Type by subsequent designation, *Eosurcula moorei* (Gabb), Vokes, 1939, Ann. New York, Acad. Sci., 38, p. 118 and again, same type, Gardner, 1945, Mem. 11, Geol. Soc. America, p. 235.



Plate 298. *Eosurcula moorei* (Gabb, 1860). Caldwell County, Texas (Eocene). 33 mm. (from Harris, 1937, pl. 8, fig. 10).

### Genus *Hemisurcula* Casey, 1904

Type: *Pleurotoma silicata* Aldrich, 1895

This is an Eocene genus so far known only from the Tuscahoma formation of the Southern United States and the Midway formation in Northern Mexico.

Casey's description is - "In this genus the shell is fusiform, with the embryo conoidal, multi-spiral and closely coiled, the nepionic spire whorls alone costate and having also an elevated collar below the suture. The more recent whorls become devoid of lyrae or costae, though having throughout densely close-set and subequal microscopic striae, except the body-whorl abruptly below the posterior end of the aperture, which is obliquely and rather coarsely lyrate". (i.e. "lyrate" = lirate). The type is illustrated in plate 299.

Characteristic species - *silicata* (Aldrich, 1895) and *eosilicata* Gardner, 1945.

#### Synonymy -

1904 *Hemisurcula* Casey, Trans. Academy of Science, St. Louis, vol. 14, p. 150. Type by original designation: *Pleurotoma silicata* Aldrich, 1895.



Plate 299. *Hemisurcula silicata* (Aldrich, 1899). Lower Sabine, Alabama (Eocene). 26 mm. (from Harris, 1937, pl. 11, fig. 22).

### Genus *Leptosurcula* Casey, 1904

Type: *Pleurotoma beadata* Harris, 1895

Another elongate-fusiform genus from the lower Claiborne Eocene of Texas, which differs mainly from *Eosurcula* and *Protosurcula* in having in addition to spiral sculpture, relatively large oblique costae and a subsutural collar of small close-set nodules.

The protoconch is relatively very large, higher than wide, conical and composed of five or six polished whorls, gradually acquiring close-set longitudinal riblets, and then equally gradually, the spiral lirae. The type is illustrated in plate 300.

#### Synonymy -

1904 *Leptosurcula* Casey, Trans. Academy Science, St. Louis, vol. 14, p. 157. Type by original designation: *Pleurotoma beadata* Harris, 1895, Smithville, Texas, Claiborne, Eocene.

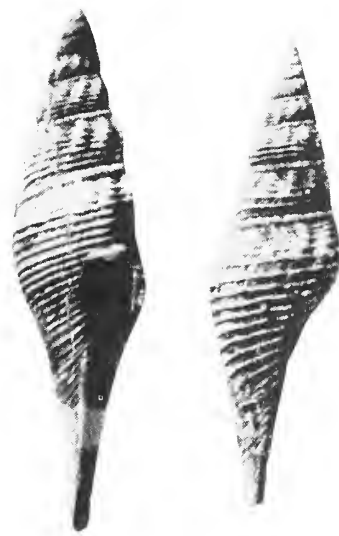


Plate 300. *Leptosurcula beadata* (Harris, 1895). Smithville, Texas (Eocene). 30 mm. (from Harris, 1937, pl. 13, figs. 30, 31).

**Genus *Orthosurcula* Casey, 1904**Type: *Pleurotoma longiforma* Aldrich, 1897

This genus closely resembles *Turricula* in general features: typically it is a solid fusiform shell, almost devoid of axial sculpture and with only weak spiral ornament on an otherwise polished surface. The most noticeable feature is the deep shoulder sulcus, the lower rounded edge of which is just above middle whorl height. The sinus is broad but moderately deep, with its narrowly rounded apex at the lower third of the shoulder sulcus. (See pl. 296 fig. 1)

The anterior canal is straight, without a notched anterior termination. The protoconch of the type species is of 3-3½ smooth polished whorls, rapidly increasing in size, followed by about three fourths of a whorl of sharp, obliquely arcuate costae.

The type species of *Turricula*, *flammea* Schumacher, differs only in having a smaller, fewer whorled protoconch and a flexed anterior canal with a notched termination.

Casey included the Indo-Pacific "*australis* Gmelin", i.e. Roissy, 1805, in his *Orthosurcula*, and although it has a straight unnotched anterior canal, the very deep anal sinus and the small paucispiral protoconch show that its alliance is not with the American genus, which has a compact Eocene-Oligocene range in the Southern United States.

**Synonymy—**

1904 *Orthosurcula* Casey, Trans. Academy Science, St. Louis, vol. 14, p. 151. Type by subsequent designation; Gardner, 1935; *Pleurotoma longiforma* Aldrich, 1897, Red Bluff, Mississippi, lower Oligocene.

**Characteristic species—Southern United States, Eocene:** *longipera* (Harris, 1895), *phoenicea* Gardner, 1933, *pleasanthillensis* Le Blanc, 1942, *tobar* Gardner, 1933; **Oligocene:** *longiforma* (Aldrich, 1897).

**Genus *Protosurcula* Casey, 1904**Type: *Surcula gabbii* Conrad, 1865

A genus of uncertain affinities, apparently restricted to the Lower Claiborne Eocene of the western Gulf of Mexico. The main feature of this genus is the almost complete absence of axial sculpture. The shell is moderately large, in excess of 30 mm., elongate-fusiform with tall spire and long straight canal. The protoconch is described as being conoidal and multispiral and the post-nuclear whorls lightly convex and densely lirate.

Casey remarked that the columella sometimes has a strong plication above the middle, which suggests alliance with *Plentaria*, a genus of the *Borsoniinae*. Whether or not all turrids exhibiting pillar plait are necessarily closely allied is still a matter of conjecture. The type is illustrated in plate 301.

**Synonymy—**

1904 *Protosurcula* Casey, Trans. Academy of Science, St. Louis, vol. 14, p. 144. Type by original designation: *Surcula gabbii* Conrad, 1865.



Plate 301. *Protosurcula gabbii* (Conrad, 1865). Smithville, Texas (Eocene). 43 mm. (from Harris, 1937, pl. 9, figs. 26, 30).



### The Cochlespirinid Group of Genera

This is the group of genera formerly considered by the writer to constitute a separate subfamily, the Cochlespirinae (Powell, 1942). The group was diagnosed as fusiform shells of rather light build, strongly angled or keeled at the periphery, which is plain, serrated, gemmate or coronated. They are more or less confined to deep water. The sinus is on the shoulder slope, broad and rounded to rather deep, restricted by a median spiral lamella, or narrowly sutural and deep.

The operculum is normally leaf-shaped to subquadrate, with a terminal or near terminal nucleus, or it may be vestigial.

The radula was considered diagnostic in that it consisted of a large very broad-based unicuspid central, no laterals, and modified 'wishbone-type' marginals. Later, however, the writer (1966) merged the Cochlespirinae with the Turriculinae, since further radula studies demonstrated that the presence of a well developed central tooth could no longer be considered peculiar to the Cochlespirinae, for a similar enlarged central is now known to be present in some species of *Gemmula* and *Turris* (Turricinae), *Turricula* and *Comitas* (Turriculinae), and even in *Clavatula*

(Clavatulinae). It is also worthy of note that in *Steiraxis*, an obvious close relative of *Aforia*, the central is reduced to a minute vestigial plate.

Nevertheless the "Cochlespirinae" with their relatively large thin shells, and conspicuous peripheral carina, which may be smooth, gemmate or coronated, constitute a recognisable group of genera, but not one that merits taxonomic recognition.

#### Synonymy—

1942 Cochlespirinae Powell (proposed), Bulletin No. 2, Auckland Institute and Museum, pp. 29, 68.

1966 Cochlespirinae Powell (rejected), Powell, Bulletin No. 5, Auckland Institute and Museum, p. 26.

### Genus *Cochlespira* Conrad, 1865

Type: *Pleurotoma cristata* Conrad, 1847

Shell of moderate to large size, 14-50 mm. ( $\frac{1}{2}$ -2 inches) in height, elongate-fusiform, with a tall pagodaform spire, and a long body-whorl, gradually tapered to a long unnotched anterior canal. Protoconch subglobose or subcylindrical of two smooth whorls, sometimes angulate towards its termination. Adult whorls with a more or less median placed peripheral carina, flange-like, with pointed serrated nodes, or coronated by up-curved spinose processes. Suture sometimes submargined by a spiral band of oblique oval gemmules; the rest of the concave shoulder slope either smooth, or with spiral sculpture. This

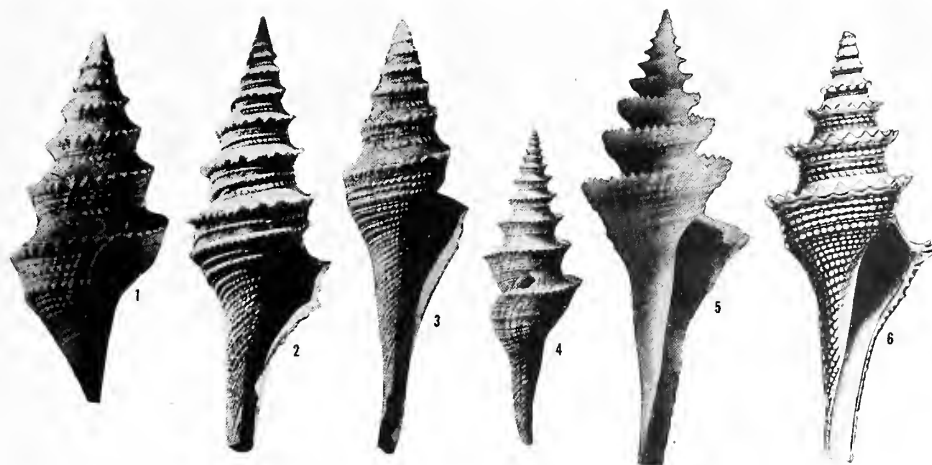


Plate 302. Fig. 1, *Cochlespira cristata* (Conrad). Vicksburg, Mississippi, Oligocene. 10 mm. (type of *Cochlespira*: from Harris, 1937, Pal. Americana, no. 7, pl. 9, fig. 1). Fig. 2, *C. bella* Conrad. Wood's Bluff, Alabama, Eocene. 22 mm. (from Harris, 1937, pl. 9, fig. 4). Fig. 3, *C. terebralis* (Lamarck). Paris Basin, Eocene (from Harris, 1937). 23 mm. Fig. 4, *C. subterebralis* (Bellardi). Vienna Basin, Miocene. 41 mm.

(type of *Rouaultia*: from Hoernes, 1856, K-K Geol. Reichsanst., Vienna, pl. 39, fig. 16a). Fig. 5, *C. elegans* (Dall, 1881). 385 fathoms off Matanzas, Cuba. 42 mm. (type of *Ancistrogyrinx*). Fig. 6, *C. venusta* (Powell). Balcombe Bay, Victoria, Australia, Balcombian Miocene (type of *Coronasyrinx*: from Powell, 1944, Rec. Auck. Inst. Mus., vol. 3, no. 1, pl. 1, fig. 1).

may be in the form of weak smooth to granulose spirals, extending up from the peripheral carina, or there may be a single plain spiral lamella, or a spiral row of granules, subdividing the shoulder slope. Below the peripheral carina the whorls vary from smooth to densely sculptured with closely spaced smooth to strongly gemmate spiral cords. In one group of species there is a second keel that encircles the upper base. Sinus moderately deep, broadly arcuate, occupying most of the shoulder slope, or narrower and restricted to above a median lamella in some species. Operculum leaf-shaped, with a terminal nucleus. Radula with a large, very broad-based, unicuspid central tooth, no laterals, but modified 'wishbone-type' marginals, which are foliated-based in *pulchella* (Plate 306, fig. C.).

*Range* – Recent: India to Japan; Pliocene: Panama; Miocene: Europe, Okinawa, Australia and Panama; Oligocene: Germany and the south eastern United States; Eocene: Europe, England, India?, the Caribbean, and the southeastern United States.

The writer is indebted to Dr. F. Stearns MacNeil for pointing out that Cossmann's designation (1896) of *Pleurotoma engonata* Conrad, 1865, as type of *Cochlespira*, is invalid, since the name *engonata* was a *nomen nudum* at the time of publication of the genus, and was not formally described until two months later. In effect this makes *cristata* monotype of the genus, alters the character of *Cochlespira*, and at the same time demands re-orientation of other names.

Up to the present the writer has endeavoured to preserve *Ancistrostrix* for a group of American Miocene to Recent shells, most of which have the sinus area divided by a lamellate spiral ridge. However, this feature is by no means constant, for in a Recent Caribbean species, *elegans* Dall, 1881, type of *Ancistrostrix*, the dividing sinus area ridge is not lamellate, but in the form of a spiral series of closely spaced gemmules. Further, one can no longer consider the lamellate ridged sinus to be confined to the tropical American area, for a new species, described following, which has a very well developed mid shoulder-slope lamella, comes from off the Queensland coast of Australia.

There now appear to be no marked differences between the respective type species of *Cochlespira*, *Ronaultia*, *Ancistrostrix* and *Coronastrix*, the three latter becoming synonyms of the former. Thus the genus *Cochlespira* be-



Plate 303. Left: *Cochlespira elegans* (Dall, 1881). 385 fathoms off Matanzas, Cuba (type of *Ancistrostrix*). Right: *C. radiata* (Dall. 65 fathoms off Ragged Key, Florida ("Ancistrostrix"). Showing the mid-shoulder lamella developed from a spiral series of denticles. Note the similarity of the former to the Philippine *pulchella fossata*, and the latter to the Queensland *beuteli*, demonstrating that *Ancistrostrix* is a synonym of *Cochlespira*.

comes available in a wider sense, to take in most of the *Ancistrostrix*-like shells that do not have the shoulder slope divided by a spiral lamella.

To the synonymy of *Cochlespira* must now be added *Pagodastrix* Shuto, 1969, published as a subgenus of *Ancistrostrix*, and with *Pleurotoma* (*Ancistrostrix*) *travancorica* variety *granulata* E. A. Smith, 1904, as type, an unfigured shell of uncertain status, from off Travancore, India, in 360 fathoms. Shuto's figures of a Panay Island Neogene fossil, as representing Smith's *granulata*, are almost certainly identical with Schepman's *pulchella*.

For *engonata*, formerly considered the type of *Cochlespira*, the genus *Cochlespiopsis* Casey, 1904, becomes available, based upon a Claiborne Eocene shell with plain carinated whorls. A lectotype of *Pleurotoma cristata* Conrad, 1847, type species of *Cochlespira*, from the southern United States = Vicksburg Oligocene, is in the Academy of Natural Sciences of Philadelphia (Moore, 1962, Proc. ANSP., vol. 114, p. 51).

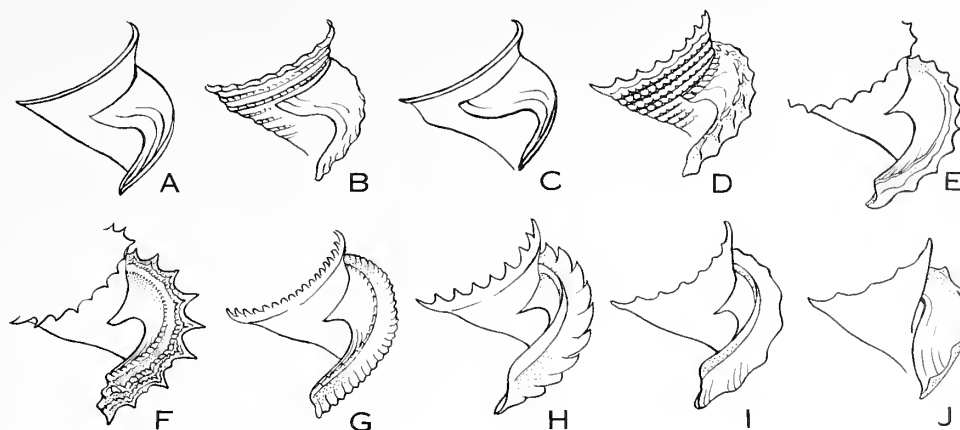


Plate 304. Oblique views of the sinus: A. *Cochlespiopsis engonata* (Conrad). Eocene, Texas. B. *Tahusyrinx maorum* (Marshall & Murdoch). Eocene, New Zealand. C. *Parasyrinx alta* (Harria). Lower Miocene, New Zealand. D. *Cochlespira venusta* (Powell). Middle Miocene, Victoria, Australia. E. *Cochlespira pulchella scnipolita* Powell, new species. 182 fathoms, Philippines. F. *Cochlespira pulchella fossata* Powell, new subspecies. 385 fathoms, Philippines. G. *Coch-*

*lespira elegans* (Dall). 385 fathoms, Cuba. H. *Cochlespira radiata* (Dall). 60 fathoms, Florida. I. *Cochlespira beuteli* Powell, new species. 68 fathoms, south Queensland. J. *Thatcheriasyrinx orientis* (Melvill). 156 fathoms, Gulf of Oman. (Note the mid-shoulder lamella in figs. H and I, and its development from rugose to granulose spirals in figs. D-G; and also the sutural daphnelid-like sinus in J).

### Synonymy—

- 1865 *Cochlespira* Conrad, American Journal of Conchology, vol. 1, p. 19. Type: by virtual monotypy: *Pleurotoma cristata* Conrad, 1847.  
 1878 *Rouaultia* Bellardi, Mem. Accad. Sci. Torino, 2, 29, p. 223. Type: by subsequent designation, Cossmann, 1896: *Pleurotoma subterebralis* Bellardi, 1847.  
 1878 *Candelabrum* Dall, Bulletin Museum of Comparative Zoology, no. 5, p. 61 (non *Candelabrum* Blainville, 1830).

- 1881 *Ancistrosyrinx* Dall, Bulletin Museum of Comparative Zoology, vol. 9, no. 2, p. 53. Type: by original designation: *Ancistrosyrinx elegans* Dall, 1881.  
 1944 *Coronasyrinx* Powell, Records Auckland Institute and Museum, vol. 3, no. 1, p. 22. Type: by original designation: *Coronasyrinx venusta* Powell, 1944.  
 1969 *Pagodasyrinx* Shuto, Memoirs Faculty Science, Kyushu University, series D, Geology, vol. 19, no. 1, p. 190. Type: by original designation: *Pleurotoma* (*Ancistrosyrinx*) *travancoria* (sic) *granulata* E. A. Smith, 1904.

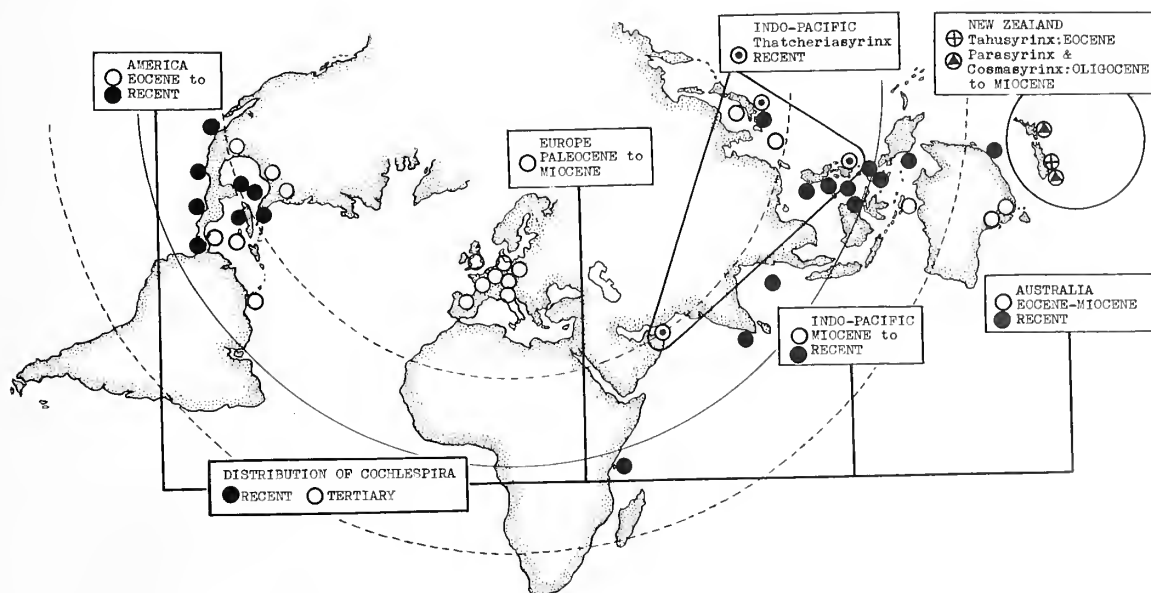


Plate 305. Geographical distribution of *Cochlespira* and the allied genera *Thatcheriasyrinx*, *Tahusyrinx*, *Parasyrinx*

and *Cosmasyrinx*. (Note the absence of *Cochlespira* in Europe from later than the Miocene).



***Cochlespira travancorica subspecies  
travancorica* (E. A. Smith, 1896)**

(Pl. 307)

**Range**—Off east India.

**Description**—Shell narrowly fusiform, of moderate size, 40 mm. (1 $\frac{5}{8}$  inches) in height, with a tall pagodaform spire and a long straight anterior canal. The spire-whorls, at about three-fourths whorl height, are sharply angulated and coronated by a thin lamella which is produced into somewhat irregular upward curved broad based spines. Above the carina the shoulder is concave but from the carina to the lower suture the outlines are straight but inclined inward below. The body-whorl tapers gradually to a long straight anterior canal. The shell surface is smooth except for weak spiral cords over the lower base and rostrum. The sinus is broad and rather deep, extending from the suture almost to the peripheral carina. Colour dull white under a thin greyish periostracum.

**Measurements (mm.)—**

height	width	
40.0	10.0	holotype

**Synonymy—**

1896 *Pleurotoma* (*Ancistrosyrinx*) *travancorica* Smith, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 368.

1909 *Pleurotoma* (*Ancistrosyrinx*) *travancorica* Smith; Anandale and Stewart, Illustr. Zool. Investigator, Moll., pt. 6, pl. 7, figs. 1, 1a.

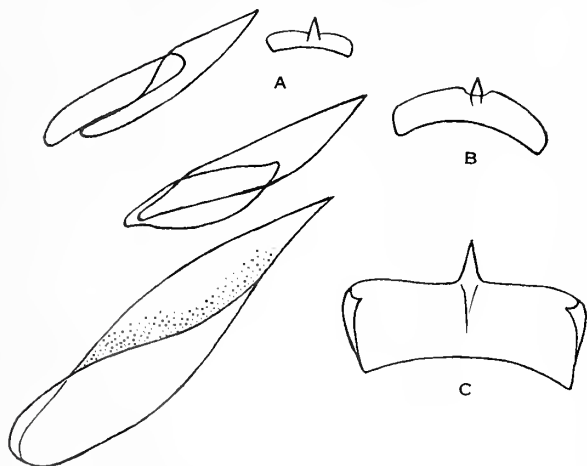


Plate 306. Radulae of *Cochlespira*. A. *cedonulli* (Recve), 153 fathoms, Gulf of Panama. B. *elegans* (Dall), 197 fathoms, Florida. C. *pulchella* (Schepman). 250 metres, Banda Sea, Indonesia.

**Types**—The holotype is in the Indian Museum, Calcutta, and there are two virtual topotypes in the British Museum (Natural History).

**Records**—INDIA: off Travancore, 406 fathoms (holotype); off Travancore, 360 fathoms (two specimens in Brit. Mus. (N.H.)).

***Cochlespira travancorica travancorica  
forma granulata* (E. A. Smith, 1904)**

**Range**—Off east India.

**Remarks**—A young example of only 19 mm. in height, from the Murray Expedition sta. 107, off Mombasa in 439 metres, may represent this subspecies, and if so, there is little justification for its separation from the typical species. In this specimen there are two weak smooth spiral threads in the middle of the shoulder sulcus and the lower base and rostrum are sculptured with linear-spaced flat-topped cords. The upper five or six of them have the linear grooves strongly scalloped in harmony with the dentations of the peripheral keel, but the remainder are straight, separating plain spirals.

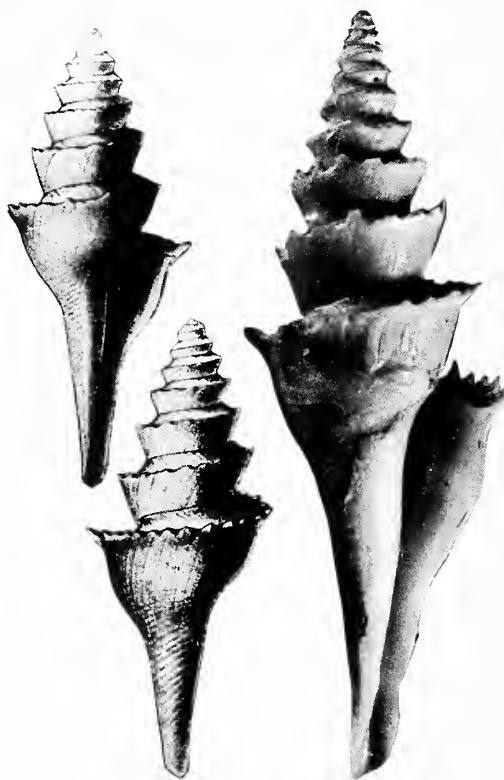


Plate 307. *Cochlespira travancorica* (E. A. Smith). Left: 406 fathoms off Travancore, India, two views of holotype. Right: 360 fathoms off Tranvancore (British Museum Nat. Hist.). 40 mm.

Insufficient material is available to assess the true status of the var. *granulata*, which in the meantime is admitted only as a form of the typical species.

The writer has not seen this 'variety', the type of which has never been figured, nor is it certain that it was ever designated. The original description is as follows:—"Three specimens from off Travancore differ from the type in having the lower part of the body-whorl covered with oblique rows of minute granules, also in having a spiral liration in the concavity of the whorls near the dentate keel. This liration bears small tubercles connected by short cross-ridges with the dentations of the keel. Two examples from the latter locality (Andaman Islands) have the dentations at the angle of the whorls conspicuously upturned, so that the upper part of the volutions is deeply concave. The latter are twelve in number, of which the apical one is smooth and globular."

#### Measurements—(not given)

Records—INDIA: off Travancore, 360 fathoms. ANDAMAN ISLANDS: 185 and 194 fathoms (Smith, 1904). SULU ARCHIPELAGO: 462 and 522 metres (Schepman, 1913). EAST AFRICA: off Mombasa, 439 metres (Murray Exped.).

#### Synonymy—

1904 *Pleurotoma* (*Ancistrosyrinx*) *travancorica* var. *granulata* Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 13, p. 459.  
1913 *Ancistrosyrinx* *travancorica* var. *granulata* (Smith); Schepman, Siboga Exped., pt. 5, 49e, p. 420.

### *Cochlespira pulchella* (Schepman, 1913)

This species is divisible into a series of subspecies, commencing with *pulchella cornetiformis* from the Quaternary of Timor, followed by four Recent subspecies, which combined, inhabit a geographical area of from Indonesia to Japan. They live in deep water, ranging from 80-385 fathoms, and on a substratum of green or

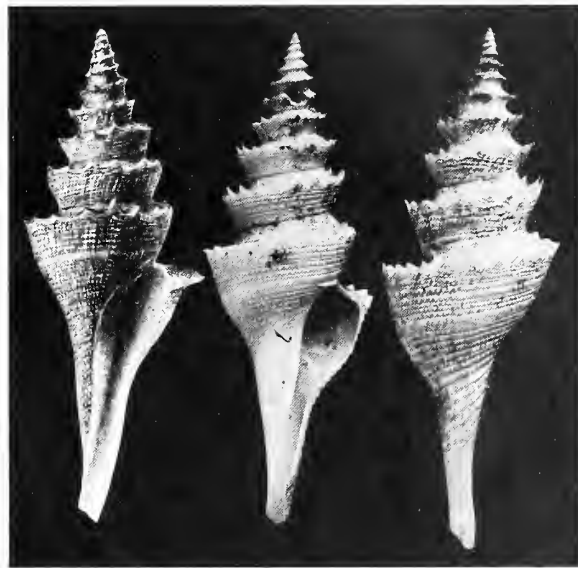


Plate 308. *Cochlespira pulchella* (Schepman). Left: between Makian and Halmahera, 472 metres. Holotype. 25 mm. (from Schepman, 1913, Siboga Exped., vol. 49e, pl. 27, fig. 6. Middle and right: Sibuko Bay, Borneo, 260 fathoms, 41 mm. and 310 fathoms, 37.5 mm.

### Key to *pulchella* subspecies

- Base evenly tapered
  - Peripheral spines sharp decidedly upcurved
    - Spines 17-22 per whorl
      - Spiral cords granulose throughout . . . . . *pulchella*
    - Spines 22-27 per whorl
      - Spiral cords obsolete on spire, smooth hiatus on base, granulose below . . . . . *semipolita*
  - Peripheral spines prominent, slightly upcurved
    - Spines 19 per whorl
      - Sinus area canaliculate . . . . . *fossata*
  - Peripheral spines small and blunt
    - Spines 24-30 per whorl
      - Spiral cords smooth except on rostrum . *pulcherrissima*
- Base with a distinct subangulation
  - Peripheral spines small, blunt, very little upcurved
    - Spines about 24-28 per whorl
      - Spiral cords subobsolete on spire, granulose below . . . . . *cornetiformis*

grey mud and fine sand. The associated bottom temperatures range between 44.3°F. and 55.8°F. The geographical area for *pulchella pulchella* is Indonesia, Halmahera, Borneo and the Banda Sea; for *pulchella semipolita* and *pulchella fossata* the Philippines; and for *pulchella pulcherrissima* south eastern Honshu, Japan

*Cochlespira pulchella subspecies pulchella* (Schepman, 1913)

(Pl. 308)

*Range*—Indonesia, deep water.

*Remarks*—Shell elongate-fusiform, of moderate size, 25-41 mm. (1-1<sup>5</sup>/<sub>8</sub> inches) in height, with a tall pagodaform spire, and a long narrow straight anterior rostrum. Whorls 11-12, including a small smooth obtusely conical protoconch of almost two whorls. Spire whorls coronated at above middle-whorl height by upcurved sharply pointed trigonal spines, 17-22 per whorl, thickened above and bordered by a narrow thread.

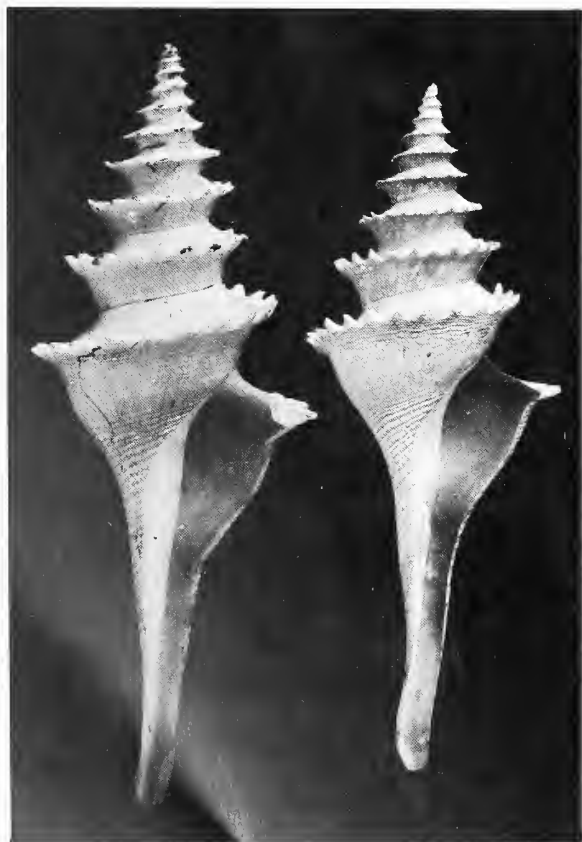


Plate 309. *Cochlespira pulchella semipolita* Powell, new subspecies. Left: off Abgao, Leyte, Philippines, 182 fathoms. Holotype. 51.5 mm. Right: 312 fathoms west of Baracay Island, Philippines, 47.25 mm.

The concave shoulder slope is smooth except for numerous weak growth lines, defining successive positions of the sinus. Below the periphery the walls are smooth for six or seven whorls, after which relatively strong linear-spaced flat-topped spiral cords develop, and these are densely beaded by axial linear grooves. The cords number 8-10 on the penultimate and 30-38 on the body-whorl, including the base and rostrum. Sinus deep, with a relatively narrowly rounded apex, at above the middle of the shoulder slope. The colour is pale yellowish-brown, except for the peripheral spines, a slightly stronger cord on the upper base, the parietal callus, the interior of the aperture, and the rostrum, which are whitish.

*Measurements* (mm.)—

height	width	
41.0	13.15	Borneo, S. E. of Mabul Id., 310 fathoms.
37.5	13.00	Borneo, Sibuko Bay, 260 fathoms.
25.0	9.50	holotype

*Records*—INDONESIA: channel between Makjan and Halmahera, 472 metres, Siboga Sta. 137 (type); Halmahera Sea, 0° 59.1'S., 129° 48.8'E., 411 metres; Borneo, S. E. of Mabul Id., Sibuko Bay, 310 fathoms, bottom temperature 44.3°F. (Albatross Sta. 5590, USNM239121); Sibuko Bay, 260 fathoms, bottom temperature 45.7°F. (Albatross Sta. 5589, USNM239091); E. of Sipada Id., Sibuko Bay, 347 fathoms, bottom temperature 44 F. (Albatross Sta. 5586, USNM 239060); S. of Silungan Id., 305 fathoms, bottom temperature 43.3 F. (Albatross Sta. 5592, USNM229302); Banda Sea, near Kei Islands, 5° 46'S., 132° 49' 35"E., 352 metres; 5° 32'S., 132° 36' 25"E., 250 metres (Th. Mortensen Sta. 52, 7 May 1922) and Sta. 63, 16 May 1922, 290 metres; (Zool. Mus., Copenhagen).

*Synonymy*—

1913 *Ancistrosyrinx pulchella* Schepman, Siboga Exped. Pt. 5, 49e, p. 421, pl. 27, fig. 6.

*Type*—The holotype is in the Zoological Museum, Amsterdam.

*Cochlespira pulchella new subspecies semipolita* Powell

(Pl. 309)

*Range*—Philippines, deep water.

*Remarks*—This seems to be a well marked regional subspecies that is confined to the Philippines Islands. It lives on green mud, grey mud and fine sand, or grey mud with *Globigerina*.

*Description*—Shell rather large, 42-52 mm. (1<sup>5</sup>/<sub>8</sub>-2 inches) in height; similar to the typical species but proportionately wider, and with the upcurved peripheral spines emanating from a more projecting flange. The chief difference is in the spiral sculpture which is absent from the spire-whorls, except for several undulating threads both above and on the underside of the



peripheral flange. Also, on the body-whorl, the spirals which are finer and weaker than in the typical species, are weakly granulose but only below a smooth hiatus, of varying width, that encircles the upper part of the base. The peripheral spines, which are hollow, triangular and upcurved, number 23 on the last whorl in the holotype, and between 22 and 27 in other material. The sinus is very deep but rather broadly rounded at its apex, the whole occupying the smooth part of the shoulder area, from the suture to the several fine undulating spiral threads on the upper surface of the peripheral carina. The colour is dull white under a very thin, pale buff periostracum.

*Measurements (mm.)—*

height	width	
51.5	18.5	holotype. Leyte, 182 fms.
47.25	17.0	Panay, 312 fms.
42.0	16.5	Panay, 312 fms.

*Types*—The holotype (USNM 240437) and the other locality lots are in the United States National Museum, Washington.

*Records*—PHILIPPINES: off Malabrigo Light, east Mindoro, 283 fms. (Albatross Sta. 5123, USNM 262062); west of Baracay Id., Panay, 312 fms. (Albatross Sta. 5259, USNM 230883); off Abgao, Leyte, 182 fms., bottom temperature 55.7° F. (Albatross Sta. 5403, USNM 240437) (type); off Lauis Point, Cebu, 145 fms., (Albatross Sta. 5411, USNM 238314).



Plate 310. *Cochlespira pulchella fossata* Powell, new subspecies. 385 fathoms off Danao, Cebu, Philippines. Holotype. 32.5 mm.

*Cochlespira pulchella* new  
subspecies *fossata* Powell

(Pl. 310)

*Range*—Philippines, deep water.

*Remarks and Description*—Shell of medium size, up to 33 mm. (1¼ inches) in height, similar to *pulchella* typical in its granular spiralled surface sculpture, but with a much more prominent spinose-armed keel, which is margined above by a wide scabrous to finely spinose-spiralled flat area, beyond which is a concave deeply sunken smooth sinus area, extending to the suture. The peripheral spines number 19 on the last whorl in the holotype; they are long, narrowly triangular, very sharply pointed, upcurved over the early whorls, but horizontal to slightly depressed over the last whorl. There are 7-8 finely beaded, linear-spaced spiral cords from the peripheral carina to the lower suture on the last two whorls, and about 34 on the base and rostrum. The protoconch is small smooth and vitreous of 1½ whorls, the tip slightly oblique. The sinus is deep with a rather broadly rounded apex, and occupies the entire smooth shoulder sulcus. Colour white under a very thin pale buff periostracum; the smooth sinus area silvery to iridescent.

This subspecies occurs on green mud and grey mud with fine sand, from 159-385 fathoms.

*Measurements (mm.)—*

height	width	
32.5	14.0	holotype. Cebu, 385 fathoms, Philippines

*Types*—The holotype (USNM230898) and other paratype lots are in the United States National Museum, Washington.

*Records*—PHILIPPINES: off Cabilao Id., west Bohol, 174 fathoms, bottom temperature 54.3°F. (Albatross Sta. 5197, USNM280796); off Villalia, Leyte, 188 fathoms, bottom temperature 55.8°F. (Albatross Sta. 5402, USNM238235); off Capitancillo Id., north Cebu, 182 fathoms, bottom temperature 55.7°F. (Albatross Sta. 5403, USNM287718); off Dupon Bay, Leyte, 190 fathoms (Albatross Sta. 5404, USNM229381); off Danao, Cebu, 385 fathoms (Albatross Sta. 5410, USNM 230898) (holotype); off Lauis Point, east Cebu, 165 fathoms, bottom temperature 54.4° F. (Albatross Sta. 5417, USNM 288528); off Lauis Point, 159 fathoms (Albatross Sta. 5418, USNM 238393); west of Siquijor, 254 fathoms, bottom temperature 53.5°F. (Albatross Sta. 5537, USNM229369); off Mindanao, 219 fathoms, bottom temperature 53.3°F. (Albatross Sta. 5541, USNM238927).

***Cochlespira pulchella subspecies pulcherrissima* (Kuroda, 1959)**

(Pl. 311)

*Range*—Japan, deep water.

*Remarks*—Shell of moderate size, 29.5-34.5 mm. ( $1\frac{1}{8}$ - $1\frac{3}{8}$  inches) in height, similar to the typical species but with more numerous peripheral spines, 24-30 on the last whorl, smaller, blunter and very little upcurved. Also the spiral cords have deeper linear incised interspaces and only over the lower base and rostrum do they become noticeably granulose. The concave shoulder slope is smooth except for 2 or 3 smooth to scabrous lirae, margining the peripheral spines. The sinus is deep and narrowly U-shaped, its apex in the middle of the smooth area. In a dried state the shell is pale orange-buff, but Kuroda (1959, l.c.) described the fresh shell as pale roseate.

*Measurements (mm.)—*

height	width	
34.5	12.4	Kuroda, 1959, pl. 20, fig. 2. Holotype?.
30.5	10.25	Japan, Tosa, deep water
29.5	11.25	Japan, Tosa, deep water

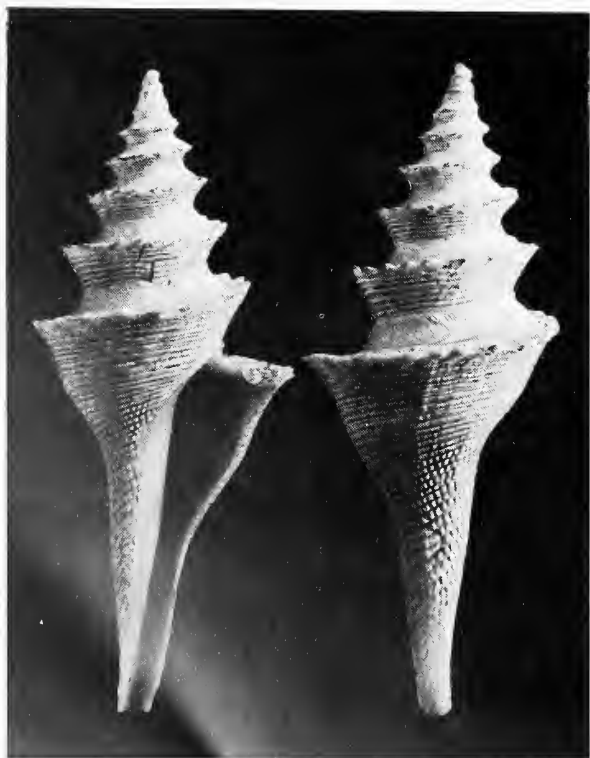


Plate 311. *Cochlespira pulchella pulcherrissima* (Kuroda). 80-100 fathoms off Tosa, Japan. 30.5 mm.

*Synonymy—*

- 1954 *Ancistrosyrinx pulcherrissima* (Kuroda ms.) Kira, Col. Illustr. Shells Japan, pl. 35, fig. 1 (nom. nud.)  
 1959 *Ancistrosyrinx pulcherrissima* Kira; Kira, Col. Illustr. Shells Japan (7th. edit.), pl. 35, fig. 1 (nom. nud.)  
 1959 *Ancistrosyrinx (Coronasyrinx) pulcherrissima* Kuroda, Venus, vol. 20, no. 4, pl. 20, fig. 2 (description).  
 1962 *Ancistrosyrinx pulcherrissima*; Kira, Shells of the Western Pacific in Colour (English edit.), p. 100, pl. 36, fig. 1.

*Records*—JAPAN: southern coast of Honshu, Pacific side, 80-100 fathoms (Kuroda, 1959); Tosa, in deep water (ANSP).

***Cochlespira pulchella subspecies cornetiformis* (Tesch, 1915)**

(Pl. 312)

*Range*—Pliocene of Timor.

*Remarks*—This subspecies is possibly directly ancestral to the Recent *pulchella pulchella*, from which it differs, according to the original figures, only in being slightly broader in the spire, and in having the peripheral spines smaller, blunt and very little upcurved, as well as having a decided subangle encircling the base.

*Measurements (mm.)—*

height  
 10-25 (the original figures are of examples minus the anterior canal).

*Synonymy—*

- 1915 *Pleurotoma (Surcula) cornetiformis* Tesch, Palaont. von Timor, vol. 5, pt. 9, Jungtert und Quartare Moll. von Timor, p. 29, pl. 78, figs. 59a, 59b.

*Records*—TIMOR: Noil Lioe, Pliocene.



Plate 312. *Cochlespira pulchella cornetiformis* (Tesch). Noil Lioe, Timor, Pliocene. 10-25 mm. (incomplete).

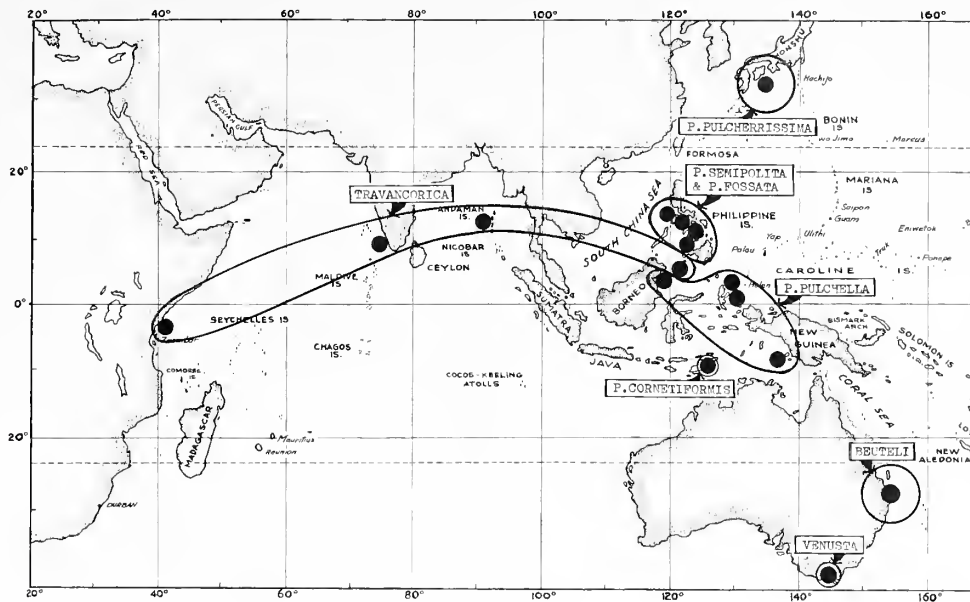


Plate 313. Geographical distribution of *Cochlespira travancorica* (E. A. Smith); *pulchella* (Schepman) and subspecies *semipolita* Powell, new subspecies, *fossata* Powell, new subspecies, *cornetiformis* (Tesch) and *pulcherrissima* (Kuroda); also *beuteli* Powell, new species and *venusta* (Powell). A ringed spot indicates a Tertiary species.

### *Cochlespira venusta* (Powell, 1944)

(Pl. 302, fig. 6)

*Range*—Miocene of Victoria, Australia.

*Remarks*—This species is characterized by its strongly gemmate spiral cords and its gemmate subsutural margining cord.

*Description*—Shell narrowly fusiform, rather small, 14.8 mm. ( $\frac{9}{16}$  of an inch) in height. Spire whorls keeled and coronated medially by strong upcurved tubercles, about 18 per whorl; anterior canal long and straight. Shoulder smooth except for a subsutural margining spiral cord of oblique oval gemmules, and two similar but much weaker spirals immediately above the coronated keel. From the keel downward there are four strong closely spaced gemmulate spiral cords on the spire whorls, and about 27 from the periphery to the tip of the anterior canal. One of these cords, much stronger than the rest emerges from the lower suture and encircles the base. Sinus moderately deep, U-shaped, broadly rounded at its apex, and occupying the whole of the smooth area of the shoulder slope.

#### *Measurements (mm.)*—

height	width	
14.8	5.8	holotype

#### *Synonymy*—

1944 *Coronasyrinx venusta* Powell, Rec. Auck. Inst. Mus., vol. 3, no. 1, p. 22, pl. 1, fig. 1.

*Type*—The holotype is in the Auckland Museum (TM957).

*Records*—VICTORIA: Balcombe Bay, Balcombian, middle Miocene (holotype); Torquay, upper beds, middle Miocene.

### *Cochlespira osawanoensis* Tsuda, 1959

*Range*—Miocene of Japan.

*Remarks*—The writer has little information about this species, other than the description and figure of an imperfect supplementary specimen recorded by Shuto (1961).

From Shuto's figure the species is shown to have a conspicuous flange-like nodulose carina, which is set below middle whorl height. The suture is supramargined by a smooth cord, the shoulder slope is wide and lacks a median lamella, but there are sublamellate interrupted costae spirally arranged just above the periphery. The sinus occupies the full area between the upper suture and the suprapерipheral spiral costae.

#### *Synonymy*—

1959 *Ancistrosyrix osawanoensis* Tsuda, Journ. Fac. Sci. Niigata Univ., ser. 2, vol. 3 (2), p. 99, pl. 6, figs. 7a, 7b, 8.

1961 *Ancistrosyrix osawanoensis* Tsuda; Shuto, Mem. Fac. Sci. Kyushu Univ. ser. D, Geol. vol. 11 (2), p. 100, pl. 4, fig. 14; text fig. 8.

*Records*—JAPAN: Yatsuo group (type); brook side cliff, south of Kakoi, Mino mura, Koyu gun, Miyazaki Prefecture, middle Miocene (Shuto, 1961).



Key to the *semiplana* group

- Prominent basal keel, additional to peripheral one  
 Basal keel plain  
   Peripheral keel rising to median position  
     Spire broadly conical . . . . . *semiplana*  
 Basal keel granulose  
   Peripheral keel almost at lower suture . . . *takabanarensis*  
   Peripheral keel above one third whorl height  
     Spire rather broadly conical . . . . . *kuroharae*  
     Spire narrowly conical . . . . . *simillima*

*Cochlespira semiplana* (Powell, 1944)

(Pl. 314, fig. 2)

*Range*—Upper Eocene of South Australia.*Remarks*—Known only from the holotype which is not fully adult and has much of the ventral surface broken away.

*Description*—Shell elongate-fusiform, of small size, 9.6 mm. ( $\frac{3}{8}$  of an inch) in height, but obviously not fully adult. The spire is rather broadly conical and less than half the height of the body-whorl plus the anterior canal, but the proportions would probably alter in an adult shell. Whorls  $5\frac{1}{2}$ , including a subglobose smooth protoconch of  $1\frac{1}{2}$  whorls, the tip lateral, and the last whorl medially distinctly angulate. The post-nuclear whorls have a conspicuous flange-like peripheral carina, bearing weak tubercles, about 20 on the last whorl, commencing almost at the lower suture but later rising almost to a median position. The only other sculpture is a prominent second flange-like keel, but a smooth one, on the upper base, followed by 21 crisp plain threads, which extend to the end of the rostrum. Sinus moderately deep, U-shaped, occupying the whole of the shoulder slope.

*Measurements (mm.)*—

height	width
9.6	3.9

*Synonymy*—

1944 *Coronasyrinx semiplana* Powell, Records of the Auckland Institute and Museum, vol. 3, no. 1, p. 22, pl. 1, fig. 2.

*Type*—The holotype is in the Auckland Museum (TM957).

*Records*—SOUTH AUSTRALIA: Aldinga lower beds, Aldingan, upper Eocene.

*Cochlespira takabanarensis* (MacNeil, 1960)

(Pl. 314, fig. 1)

*Range*—Miocene of Okinawa.

*Description*—Shell elongately fusiform, of moderate size, 33 mm. ( $1\frac{5}{16}$  inches) in height, with a tall pagodiform spire, the nodulose peripheral carina low down, almost at the lower suture, causing the shoulder slope to be straight and steeply descending. The pointed peripheral nodes appear to be about 18 per whorl. A feature of the shell is a second strong finely granulose keel that encircles the base just below the top of the aperture. Protoconch smooth of two whorls, the first small and tilted, the second more swollen and developing a weak peripheral angulation towards its close. Adult whorls with the sub-sutural slope smooth, except for weak sinus growth lines, but the base bears numerous closely spaced weak spirals. Sinus moderately deep, U-shaped, its apex just above the peripheral keel.

*Measurements (mm.)*—

height	width
33.0	11.4

*Synonymy*—

1960 *Coronasyrinx takabanarensis* MacNeil, U.S. Geol. Surv. Prof. Paper 339, p. 109, pl. 5, fig. 21.

*Types*—The holotype is in the United States National Museum, Washington.

*Records*—OKINAWA: Yonabaru Clay, Miocene.

*Cochlespira kuroharae* (Kuroda, 1959)*Range*—Japan, deep water.

*Remarks*—The species is similar to *takabanarensis* from the Miocene of Okinawa, in the presence of a strong basal carina, but the peripheral carina is much heavier and is situated slightly

higher up on the spire-whorls, resulting in a shorter subsutural slope and a less sagged appearance.

**Description**—Shell elongate-fusiform, rather solid, of moderate size, 31 mm. (1¼ inches) in height, with a pagodiform spire, and a long straight anterior canal. Whorls ten, including a smooth and glossy globose protoconch of 1½ whorls. On the post-nuclear whorls, the bluntly rounded peripheral keel is situated at about one third whorl height, and is sculptured with numerous subtriangular, pointed, but not hollow spines, which number about 38 on the last whorl, and are bordered below by a thickish rib. About 20 subsidiary spiral semigranular cords on the base and caudal rostrum. Sinus deep, U-shaped, its apex at about the middle of the shoulder slope.

**Measurements (mm.)—**

height	width
31.0	11.2

**Records**—JAPAN: off Tosa (type locality).

**Synonymy—**

1959 *Ancistrosyrinx* (*Coronasyrinx*) *kuroharae* Kuroda, *Venus*, vol. 20, no. 4, p. 332, text fig. 2.

***Cochlespira simillima* new species Powell**

(Pl. 314, fig. 3)

**Range**—Philippines, deep water.

**Remarks**—This species appears to be closely allied to both the Miocene *takabanarensis* and the Recent *kuroharae*. It is more slender than either, but is probably nearer allied to the latter than the former. The Okinawan fossil differs from both Recent species in having the peripheral keel low down almost at the lower suture. It is possible that all three may be closely enough related to merit only subspecific status, but examination of material at present unavailable would be necessary to determine this.

**Description**—Shell elongate-fusiform, rather small, 20.75 mm. (ca ¾ of an inch) in height, with a tall slender pagodiform spire and a long straight anterior canal. Whorls 9½, including a small smooth, glossy protoconch of 1½ whorls, which develops a weak subperipheral angulation just before its termination. On the spire-whorls a narrowly rounded nodulose flange-like periph-

eral keel is situated at a little above one third whorl height, and a second keel, which is equally strong but smooth to weakly granulose, encircles the base, and also supramargins the lower suture as a half emergent cord. There are about 22 blunt protractively oblique nodes on the peripheral carina. Surface sculpture otherwise confined to 10 or 12 smooth to minutely granulose spirals on the base, becoming obsolete over the rostrum. The specimen from Albatross Sta. 5523 has the basal carina and subsidiary spirals noticeably granulose. Sinus moderately deep U-shaped, with a broadly rounded apex, and it occupies the whole of the shoulder area.

**Measurements (mm.)—**

height	width	holotype
20.75	6.75	

**Records**—PHILIPPINES: Jolo Sea, off Cagayan Island, 495 fathoms, bottom temperature 49.4° F. (Albatross Sta. 5425, USNM238445) (holotype); off Point Tagolo, north Mindanao, (Albatross Sta. 5523, USNM 290154).

**Type**—The holotype (USNM238445) is in the United States National Museum, Washington.



Plate 314. Fig. 1, *Cochlespira takabanarensis* (MacNeil). Yonabaru clay, Okinawa, Miocene. Holotype. 33 mm. (from MacNeil, 1960, U. S. Geol. Surv. Prof. Paper 339, pl. 5, fig. 21). Fig. 2, *Cochlespira semiplana* (Powell). Aldinga, lower beds, Aldinga, Upper Eocene. 9.6 mm. (from Powell, 1944, Rec. Auck. Inst. Mus. vol. 3, no. 1, pl. 1, fig. 2). Fig. 3, *Cochlespira simillima* Powell, new species. 495 fathoms off Cagayan Island, Jolo Sea, Philippines. Holotype. 20.75 mm.

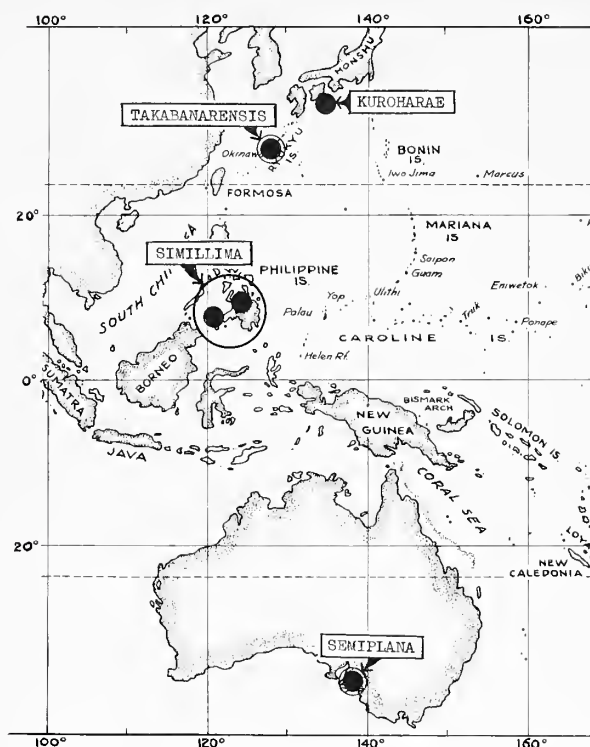


Plate 315. Geographical distribution of *Cochlespira kuroharae* (Kuroda), *C. takabanarensis* (MacNeil), *C. simillima* Powell, new species, and *C. semiplana* (Powell). A ringed spot indicates a Tertiary species.

### *Cochlespira beuteli* new species Powell

(Pl. 316)

*Range*—Off Queensland, Australia.

*Remarks*—This is the first cochlespirid with a lamellate sinus area rib to be found outside the tropical American area. Except for the deep sinus the species is superficially very like a *Columbarium*.

The species name commemorates the finder, Mr. B. Beutel of Queensland, who has provided a fine range of Queensland turrids.

*Description*—Shell fusiform, of rather small size, 22.5 mm. ( $\frac{7}{8}$  of an inch) in height, with a broadly conical pagodiform spire and a long straight anterior canal. Protoconch of  $1\frac{1}{2}$  smooth whorls which are strongly medially carinated. Post-nuclear whorls with a conspicuous medial

spiral flange bearing sharp triangular-based cusps, with sharp slightly upcurved points, 17 on the last whorl. The surface is smooth and glossy, except for a very fine wavy thread about the middle of the area between the peripheral carina and the lower suture, a conspicuous smooth spiral lamella on the mid shoulder slope, and 12 weak spiral threads from the neck to the end of the anterior canal. The sinus is deep U-shaped with a rounded apex, but rather narrow, since the whole sinus is confined to the space between the suture and the lamella. The other half of the shoulder slope, from the lamella to the periphery is slightly protractively concave at its termination. The colour is light orange-brown, with obscure faint maculations on the under sides of the peripheral spines.

#### *Measurements (mm.)—*

height	width
22.5	10.0

*Records*—SOUTH QUEENSLAND: N. E. of Cape Moreton, 68 fathoms (B. Beutel, 1967) (holotype).

*Type*—The holotype, at present unique, is in the Auckland Museum.



Plate 316. *Cochlespira beuteli* Powell, new species. 68 fathoms off Cape Moreton, south Queensland. Holotype. 22.5 mm



### Genus *Thatcheriasyrinx* new genus Powell

This new genus is required for a group of three shells from deep water in the Gulf of Oman, the Philippines and Japan. These shells are very small, 6-10 mm. ( $\frac{1}{4}$ - $\frac{3}{8}$  of an inch) in height, yet judged by the number of whorls, 8-8½, they are apparently not juvenile and it is doubtful if they will be found to attain a much larger adult size.

The shell is *Cochlespira*-like, but very thin, is strongly carinated to coronated at the periphery, and is devoid of, or almost devoid of spiral sculpture. The chief diagnostic character of the new genus is, however, the form of the sinus, which is quite unlike that of any other cochlespirinid genus, and bears more resemblance to that of the daphnellids, in that it arises tangentially from the suture, after which it is quickly produced far forward in a great arcuate curve. In the typical cochlespirinid shell, where there is no spiral sculptural impediment, the sinus is deep U-shaped, its apex more or less median on the shoulder slope. The presence of an intermediate lamella upon the shoulder area, as in *Cochlespira*, results in that sinus being restricted to the area between the suture and the lamella, but it is still a U-shaped sinus. In *Thatcheriasyrinx*, however, there is no apparent physical cause why the sinus should be so narrowly sutural.

The genus owes its name to its superficial resemblance to a miniature *Thatcheria*.

#### *Thatcheriasyrinx orientis* subspecies *orientis* (Melvill, 1904)

(Pl. 317, figs. 1-3)

*Range*—Gulf of Oman, northern Indian Ocean, deep water.

*Description*—Shell very small, frail, vitreous, 9.5 mm. ( $\frac{3}{8}$  of an inch) in height, fusiform, with sharply carinated lamellately coronated whorls, which number 8, including the protoconch of two small smooth globular whorls. Adult whorls carinated above middle whorl height and produced into peripheral strongly upcurved triangular hollow spines, 12 or 13 on the last whorl. The surface is smooth and glossy, except for a fine thread at a little below the upper suture. The sinus is deep, sigmoid, tangential suturally, then suddenly produced arcuately forward in a broad curve to the peripheral carina. Colour

translucent whitish, with a very thin pale horny periostracum.

#### *Measurements* (mm.)—

height	width
9.5	4.0

#### *Synonymy*—

1904 *Ancistrosyrinx orientis* Melvill, Proc. Malac. Soc., Lond., vol. 6, p. 56, pl. 5, fig. 3.

*Types*—The holotype and topotypes are in the British Museum (Natural History).

*Records*—GULF OF OMAN: 24° 58'N., 56° 54'E., 156 fathoms (holotype).

#### *Thatcheriasyrinx orientis* subspecies *kawamurai* (Kuroda, 1959)

(Pl. 317, fig. 4)

*Range*—Sagami Bay, Japan.

*Remarks*—This subspecies may prove to be identical with *orientis* typical from the Gulf of Oman. The two are much closer in appearance than Melvill's figure implies, owing to the spines appearing to arise from a ridge-like keel in the drawing, whereas in fact, examination of Melvill's type shows the spines as upward outgrowths from a peripheral lamellate flange, as in



Plate 317. *Thatcheriasyrinx orientis orientis* (Melvill). 156 fathoms, Gulf of Oman. Fig. 1, Holotype, 9.5 mm. (from Melvill, 1904, Proc. Malac. Soc., 6, pl. 5, fig. 3). Figs. 2, 3, topotypes (British Mus. Nat. Hist.). Fig. 4, *Thatcheriasyrinx kawamurai* (Kuroda). Dredged, Sagami Bay, Japan. Holotype, 10.5 mm. (from Kuroda, 1959, Venus, vol. 20, no. 4, pl. 20, fig. 3). Fig. 5, *Thatcheriasyrinx* species (coronated spines eroded away), 219 fathoms off Tagolo Point, Mindanao, Philippines. 6.3 mm.

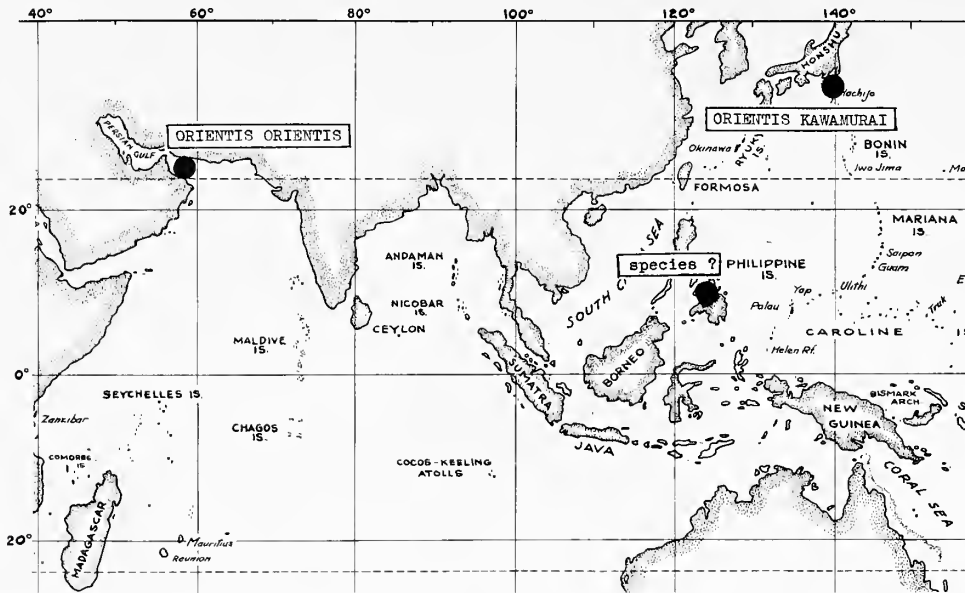


Plate 318. Geographical distribution of *Thatcheriasyrinx orientis* (Melvill) and subspecies *kawamurai* (Kuroda).

### *Thatcheriasyrinx* species

(Pl. 317, fig. 5)

*kawamurai*. The only apparent differences in *kawamurai*, and they are slight, are axial plicae on the second whorl of the protoconch, oblique spiral threads on the rostrum and the presence of a definite colour pattern.

**Description**—Shell very small, of light build, 10.5 mm. ( $\frac{3}{8}$  of an inch) in height, fusiform, with sharply carinated and lamellately coronated whorls, which number  $8\frac{1}{2}$ , including a protoconch of two subcylindrical whorls, the second with several oblique axial plicae. Adult whorls carinated at about two-thirds whorl height and produced into peripheral strongly upcurved triangular hollow spines, about 13 on the last whorl. Surface smooth except for a weak linear thread at the upper third of the shoulder slope, and subobsolete oblique spiral threads on the rostrum. Sinus sutural, tangential, then protractively slanting in a convex arcuation. Colour fleshy, irregularly mottled in brown, peripheral carina orange tinged.

#### *Measurements* (mm.)—

height	width	
10.5	4.8	holotype

**Records**—JAPAN: dredged, Sagami Bay.

#### *Synonymy*—

1959 *Ancistrosyrinx kawamurai* Kuroda, Venus, vol. 20, no. 4, p. 329, pl. 20, fig. 3.

**Remarks**—The generic record is of interest owing to its midway geographical location between the Gulf of Oman typical subspecies, *orientis*, and the Japanese subspecies, *kawamurai*. However, the single worn and damaged Philippine shell is too imperfect to place specifically. It is most likely that the shell originally had a coronated peripheral flange, in which state it would be very similar to the two above subspecies.

**Description**—Shell very small, of light build, 6.3 mm. ( $\frac{1}{4}$  of an inch) in height, elongately fusiform, loosely wound, with a tall spire, strongly carinated at about middle whorl height. The carina is a narrowly rounded projecting flange, which appears to be finely but rather irregularly granulose. Whorls six, exclusive of the incomplete protoconch; surface smooth and glossy with no trace of spiral sculpture. Sinus sutural, rapidly greatly protractively produced in a sigmoid curve across the wide shoulder concavity. Colour dull white, probably translucent when in a living state.

#### *Measurements* (mm.)—

height	width
6.3	ca. 2.75

**Records**—PHILIPPINES: off Tagolo Point, north Mindanao, 219 fathoms, bottom temperature 53.3° F., substratum fine sand and broken shell (Albatross Sta. 5541, USNM 286766).

Genus *Tahusyrinx* Powell, 1942Type: *Parasyrinx finlayi* Allan, 1926

This genus closely resembles the widespread *Cochlespira* except for a different style protoconch, which is small, broadly conical of four whorls, first two smooth and rounded, the remaining ones carinated towards the lower suture, and distantly obscurely axially ribbed. The adult shell is rather small, about 17 mm. ( $5/8$ - $3/4$  of an inch) in height, elongate-pagodiform, with a tall spire and a long body-whorl, gradually tapered to a long straight unnotched anterior canal. The spire whorls are dominated by a median flange-like keel, with a serrated edge, and the sinus is deep, U-shaped, with divergent angles of approach, the apex at about the middle of the shoulder slope.

The genus is, so far as is known, monotypic and comes from the Kaiatan Stage, upper Eocene of the Waihao greensands, McCullough's Bridge, South Canterbury, New Zealand.

## Synonymy—

1942 *Tahusyrinx* Powell, Bulletin No. 2, Auckland Institute and Museum, p. 68. Type: by original designation: *Parasyrinx finlayi* Allan, 1926.

*Tahusyrinx maorum* (Marshall and Murdoch, 1923)

(Pl. 319, fig. 1)

The characters of this sole representative of the genus are those outlined above in the generic diagnosis. Unfortunately the specific name of the type species has to give way to that of the prior published *Columbarium maorum*, which was based upon an incomplete shell from "Pukeuri", Oamaru, New Zealand, a mistaken location, as has since been proved by the adherent matrix, which is that of McCullough's Bridge (Maxwell, 1966).

## Synonymy—

1923 *Columbarium maorum* Marshall and Murdoch, Trans. N. Z. Inst., vol. 54, p. 127, pl. 13, fig. 2.

1926 *Parasyrinx finlayi* Allan, Trans. N. Z. Inst., vol. 56, p. 344, pl. 77, fig. 5.

1927 *Vesanula maorum* (Marshall and Murdoch); Finlay, Trans. N. Z. Inst., vol. 57, p. 427.

1942 *Tahusyrinx finlayi* (Allan); Powell, Bull. 2, Auck. Inst. Mus., p. 68.

1966 *Tahusyrinx finlayi* (Allan); Powell, Bull. 5, Auck. Inst. Mus., p. 42, pl. 5, fig. 8.

1966 *Tahusyrinx maorum* (Marshall and Murdoch); Maxwell, N. Z. Journ. Geol. & Geophys., vol. 9, no. 4, p. 455.

*Types*—The holotype of *maorum* is in the New Zealand Geological Survey (TM3876) and that of *finlayi* in the Auckland Museum (TM1284).



Plate 319. Fig. 1, *Tahusyrinx maorum* (Marshall & Murdoch). McCullough's Bridge, New Zealand, Kaiatan, Eocene. 17 mm. Fig. 2, *Parasyrinx alta* (Harris). Awamoa, New Zealand, Awamoan, Lower Miocene. 22 mm. Fig. 3, *Parasyrinx subalta* (Marshall & Murdoch). Otiake, Waitaki River, New Zealand, Waitakian, Lower Miocene. 30 mm. Fig. 4, *Parasyrinx* (*Lirasyrinx*) *anomala* (Powell). Whare kuri greensand, Waitaki River, New Zealand, Duntroonian, Oligocene. About 10 mm.



### Genus *Parasyrinx* Finlay, 1924

Type: *Pleurotoma alta* Harris, 1897

Shell of moderate size, 20-40 mm. ( $\frac{3}{4}$ -1 $\frac{1}{4}$  inches) in height, elongate fusiform, with a tall pagodiform spire and a long slender, almost straight, unnotched anterior canal. Protoconch small, blunt, of two rounded smooth whorls. Adult whorls dominated by a narrow sharp, flange-like smooth keel, at below middle-whorl height. A weak sub-keel or angulation encircles the base at about the level of the top of the aperture. Surface smooth to weakly lirate. Sinus deep, and broadly rounded at its apex, which occupies the lower half of the shoulder slope.

The genus is known only from the Duntroonian Stage of the Oligocene and the Waitakian, Otaian and Awamoan Stages of the lower Miocene of New Zealand. The type species, *alta* is from the Awamoan.

The monotypic genus *Cochlespiropsis* Casey, 1904, based upon *Pleurotoma engonata* Conrad, 1865 (= *C. blanda* Casey, 1904), from the lower Claiborne Eocene of Texas resembles *Parasyrinx* in its relatively smooth surface and plain peripheral keel, but the anterior end is stout and short, with a decided twist, resulting in a pronounced false umbilical chink.

#### Synonymy—

1924 *Parasyrinx* Finlay, Transactions of the New Zealand Institute, vol. 55, p. 514. Type: by original designation: *Pleurotoma alta* Harris, 1897.

#### *Parasyrinx alta* (Harris, 1897)

(Pl. 319, fig. 2)

Range—Tertiary of New Zealand.

#### Synonymy—

1873 *Pleurotoma pagoda* Hutton, Cat. Tert. Moll. N. Z., p. 5. (non Reeve, 1846)

1897 *Pleurotoma alta* Harris (nom. nov. pro *Pl. pagoda* Hutton, 1873; non Reeve, 1846), Cat. Tert. Moll. Brit. Mus., 1, p. 45.

1914 *Turris* (*Leucosyrinx*) *altus* (Harris); Suter, N. Z. Geol. Surv. Pal. Bull. 2, pl. 2, fig. 12.

1924 *Parasyrinx alta* (Harris); Finlay, Trans. N. Z. Inst., vol. 55, p. 514.

1942 *Parasyrinx alta* (Harris); Powell, Bull. 2, Auck. Inst. Mus., p. 69.

1966 *Parasyrinx alta* (Harris); Powell, Bull. 5, Auck. Inst. Mus., p. 43, pl. 5, fig. 10.

#### *Parasyrinx subalta* (Marshall & Murdoch, 1919)

(Pl. 319, fig. 3)

Range—Oligocene of New Zealand.

Remarks—Shuto (1961, Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., vol. 11, no. 2, p. 101, pl. 8, fig. 16) recorded this genus as "*Parasyrinx* n. sp.?" from Kano, Japan, upper part of Tano member, Middle Miocene. The specimen however is too badly preserved for positive acceptance of this determination.

#### Synonymy—

1919 *Leucosyrinx subaltus* Marshall and Murdoch, Trans. N. Z. Inst., vol. 51, p. 256, pl. 20, fig. 7.

1942 *Parasyrinx subalta* (Marshall and Murdoch); Powell, Bull. 2, Auck. Inst. Mus., p. 69.

Types—The holotype, from Wharekuri, Waitaki River, New Zealand (Duntroonian Stage, upper Oligocene), formerly in the Wanganui Public Museum, is now in the New Zealand Geological Survey, Wellington, New Zealand.

#### Subgenus *Lirasyrinx* Powell, 1942

Type: *Lirasyrinx anomala* Powell, 1942

This subgenus differs from *Parasyrinx* typical in having a different protoconch, which is obtusely conical of 2 $\frac{1}{2}$  whorls, the tip small, smooth and planorbid, the remainder strongly spirally lirate. Also the sinus is very deep, with a broadly rounded apex, occupying most of the shoulder slope. The adult shell closely resembles that of *Parasyrinx* except for a more prominent peripheral keel and stronger spiral sculpture.

The subgenus is based upon imperfect material, estimated at about 10 mm. in height, when complete. When more material is available the subgenus may merit full generic distinction as was originally proposed.

The genus is known only from the Duntroonian Stage of the Oligocene, Wharekuri greensand, Waitaki River, New Zealand.

#### Synonymy—

1942 *Lirasyrinx* Powell, Bulletin No. 2, Auckland Institute and Museum, p. 69. Type: by original designation: *Lirasyrinx anomala* Powell, 1942.

#### *Parasyrinx* (*Lirasyrinx*) *anomala* (Powell, 1942)

(Pl. 319, fig. 4)

Range—Oligocene of New Zealand.

#### Synonymy—

1942 *Lirasyrinx anomala* Powell, Bull. No. 2, Auck. Inst. Mus., p. 69, pl. 13, fig. 6.

1966 *Parasyrinx* (*Lirasyrinx*) *anomala* (Powell); Powell, Bull. No. 5, Auck. Inst. Mus., p. 43, pl. 5, fig. 9.

Types—The holotype and paratype are in the New Zealand Geological Survey, Wellington.

## Genus *Cosmasyrinx* Marwick, 1931

Type: *Cosmasyrinx monilifera* Marwick, 1931

Rather small shells, 12-14 mm. ( $1/2$ - $5/8$  of an inch) in height, broadly fusiform, with a pagodi-form spire and a long straight unnotched anterior canal. It is related to *Parasyrinx* but differs in having a moniliform keel, set almost at the lower suture. Protoconch paucispiral, smooth, erect, with a large bulbous nucleus. Sinus deep, broadly arcuate, occupying most of the shoulder area. Known only from the Duntroonian Stage of the Oligocene and the Altonian, Clifdenian and Lillburnian Stages of the Miocene of New Zealand. The type species is from the Ihungia Series, Gisborne, Altonian-Clifdenian Stages of the Miocene.

The shells of this genus superficially resemble squat forms of *Gemmula*, but in that genus, which belongs to the Turrinae, the sinus is in the form of a deep peripheral slit.

### Synonymy—

1931 *Cosmasyrinx* Marwick, New Zealand Geological Survey Palaeontological Bulletin No. 13, p. 138.

### List of New Zealand fossil *Cosmasyrinx*

#### *Cosmasyrinx ardua* Marwick, 1931

(Pl. 320, fig. 1)

### Synonymy—

1931 *Cosmasyrinx ardua* Marwick, N. Z. Geol. Surv. Pal. Bull. 13, p. 138, pl. 16, fig. 293.

*Types*—The holotype, from N.Z.G.S. loc. 1243, Tutamoe Series, Gisborne, Lillburnian Stage, Miocene of New Zealand, is in the New Zealand Geological Survey.

#### *Cosmasyrinx latior* Marwick, 1931

(Pl. 320, fig. 2)

### Synonymy—

1931 *Cosmasyrinx latior* Marwick, N. Z. Geol. Surv. Pal. Bull. 13, p. 139, pl. 16, fig. 294.

*Types*—The holotype, from N.Z.G.S. loc. 1361, Tutamoe Series, Gisborne, Lillburnian Stage, Miocene of New Zealand, is in the New Zealand Geological Survey.

#### *Cosmasyrinx monilifera* Marwick, 1931

(Pl. 320, fig. 3)

### Synonymy—

1931 *Cosmasyrinx monilifera* Marwick, N. Z. Geol. Surv. Pal. Bull. 13, p. 138, pl. 16, fig. 292.

*Types*—The holotype, from N.Z.G.S. loc. 1293, Ihungia Series, Gisborne, Altonian-Clifdenian Stages, Miocene of New Zealand, is in the New Zealand Geological Survey.

#### *Cosmasyrinx tereumera* Marwick, 1931

(Pl. 320, fig. 4)

### Synonymy—

1931 *Cosmasyrinx tereumera* Marwick, N. Z. Geol. Surv. Pal. Bull. 13, p. 139, pl. 16, fig. 295.

*Types*—The holotype, from N.Z.G.S. loc. 1294, Ihungia Series, Gisborne, Altonian-Clifdenian Stages, Miocene of New Zealand, is in the New Zealand Geological Survey.

#### *Cosmasyrinx semilirata* Powell, 1942

### Synonymy—

1942 *Cosmasyrinx semilirata* Powell, Bull. 2, Auck. Inst. Mus., p. 70, pl. 14, fig. 9.

*Types*—The holotype, from N.Z.G.S. loc. 2563, Longwood Subdivision, Orepuki, Southland, Duntroonian Stage, Oligocene of New Zealand, is in the New Zealand Geological Survey.

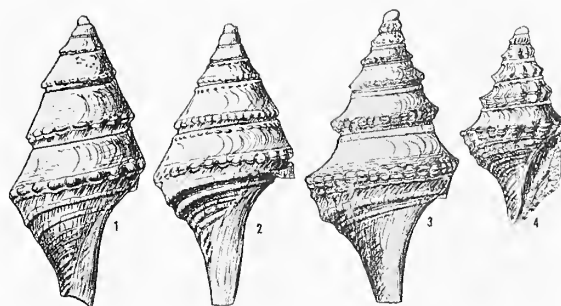


Plate 320. Fig. 1, *Cosmasyrinx ardua* Marwick. Muddy Creek, Tutamoe subdivision, Lillburnian Miocene. 13 mm. Fig. 2, *C. latior* Marwick. Pangopango Stream, Tutamoe subdivision, Lillburnian Miocene. 13.5 mm. Fig. 3, *C. monilifera* Marwick. Waingaromia subdivision, Altonian or Clifdenian Miocene. 12 mm. Fig. 4, *C. tereumera* Marwick. Waihora River, Waingaromia subdivision, Altonian or Clifdenian Miocene. 13.75 mm. All Gisborne district, New Zealand. (from Marwick, N. Z. Geol. Surv. Pal. Bull. 13, pl. 16).

### Genus *Cochlespiropsis* Casey, 1904

Type: *Pleurotoma engonata* Conrad, 1865

This genus, which is known only by its type species, *engonata*, (pl. 321) is from the Claiborne Eocene of Texas. That species, however, was formerly considered to be the type of the widespread genus *Cochlespira*, as now defined by its type species *cristata*. The genus *Cochlespiropsis* differs from *Cochlespira* in that the whorls have a plain median carina, and an overall dense surface sculpture of fine spiral lirae, weaker over the shoulder slope. The sinus is rather deep, its U-shaped apex below the middle of the shoulder slope. There is a broad shallow stromboid notch in the lower outer-lip, and the inner-lip callus bridges a narrow crescentic false umbilicus, resulting from a slightly twisted anterior canal.

#### *Synonymy*—

1904 *Cochlespiropsis* Casey, Trans. Acad. Sci. St. Louis, 14, (5), p. 143. Type: by subsequent designation; Cossmann, 1906) *Pleurotoma engonata* Conrad, 1865 (= *C. blanda* Casey, 1904).

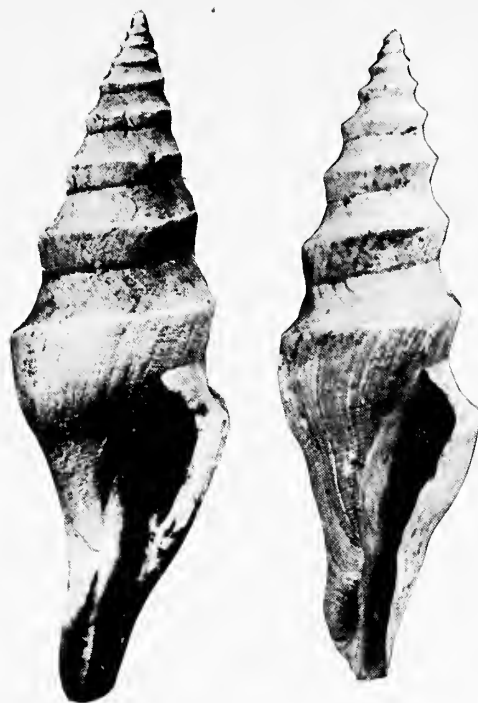


Plate 321. *Cochlespiropsis engonata* (Conrad). Left: Smithville, Texas, Eocene. 34 mm. (from Harris, 1937, Pal. Americana, Vol. 2, no. 7, pl. 11, fig. 14). Right: Stone City, Burleson County, Texas, Eocene. 26 mm.



### Genus *Aforia* Dall, 1889

Type: *Pleurotoma circinata* Dall, 1873

Shell very large, up to 92 mm. ( $3\frac{5}{8}$  inches) in height, of light build, elongate-fusiform, with a tall spire and a long slightly flexed and recurved unnotched anterior canal. The apex is almost invariably eroded or damaged, but Bartsch (1945, Journ. Wash. Acad. Sci. 35, 12, p. 388) described the protoconch as slender and multispiral. Adult whorls conspicuously medially carinated, the surface sculptured with numerous flat-topped spiral cords, defined by incised lines. This sculpture is confined to the lower half of the whorls and base, the shoulder slope being smooth, except for incremental growth threads marking successive positions of the sinus. The sinus is deep, U-shaped, with a rounded apex, occupying the lower half of the shoulder slope. In a fresh state the whole shell is covered by a thin shining buff to greyish periostracum. Occasional examples (*circinata*) develop a basal ridge that forms a spout-like subtubular projection on the lower outer lip. A similar feature often occurs in the turrid genera *Gemmula*, *Pinguigemmula* and *Ptychosyrinx*. Operculum corneous, varying in form from roughly ovate to quadrate, the nucleus terminal or subterminal, and incurved in

most instances. Dall (1908, l.c.) introduced *Irenosyrinx* for deep-water Eastern Pacific shells stated to have a different operculum from that of the deep-water North Pacific *Aforia* group. The *Irenosyrinx* operculum was stated to be paucispiral in the juvenile, later becoming surrounded by concentric additions, leaving the nucleus subcentral. However, even in the adult, the *Irenosyrinx* operculum remains vestigial so far as size is concerned, but taking into account the considerable individual fluctuations in the shape of the operculum in northern *Aforia*, there appears to be no real reason for recognising two genera, particularly since the radula is basically identical in North Pacific, Eastern Pacific, Subantarctic and Antarctic species.

The radula (Plate 324, A-F) consists of a large broad-based unicuspid central, no laterals, and a pair of modified 'wishbone-type' marginals, consisting of a massive simple pointed tooth, but with the distal basal limb severed and superimposed. The distal limb may be either small and slender, or upwards of half the size of the tooth proper. In one species, *magnifica* (fig. D), the basal limbs are not severed, and in *persimilis* (fig. E), the central is vestigial.

The *Aforia* radula is interesting in that the central has become extra large, in most instances, to fill the space that otherwise would be occupied by a lateral, and also, the modified 'wishbone-type' marginals indicate that the genus is not far removed from typical turriculids.

The distributional pattern of the genus is an excellent example of 'bipolarity' by the process of going deep under equatorial waters, in part



Plate 322. *Aforia circinata* (Dall). Fig. 1, North Pacific. 46 mm. Fig. 2, 65 fathoms off Pribiloff Islands (note labial fluting). 80 mm. Figs. 3, 4, off Okinawa, Ryukyn Islands. 87

mm. Fig. 5, *Steiraxis aulaca* (Dall). 1879 fathoms off Acapulco, Mexico. 60 mm.

assisted by the upwelling of Arctic and Antarctic waters, which factors combine to provide the requisite bottom temperature range, which is from 30.9° F. to 41.8° F., according to published data.

The genus obviously has a cold-water preference, but geographically it occurs only a few degrees short of the Tropic of Cancer, in the Okinawan record, and possibly will be found further south, underlying the tropical belt as it does in Eastern Pacific waters, and for this reason the genus qualifies for consideration in a treatise on Indo-Pacific mollusca.

*Range*—Recent: Okinawa, Japan, Korea, Bering Sea, Aleutian Islands, Alaska, down and off

the west coast of North, Central and South America, along the Scotia Arc to Antarctica to as far as the Ross Sea, the Argentine Basin, and across the Southern Ocean to Heard and Kerguelen Islands, at depths varying between 60 and 1500 fathoms. Pliocene of Japan and Miocene to Oligocene of Washington

*Synonymy*—

- 1889 *Aforia* Dall, Bulletin Museum of Comparative Zoology, vol. 18, p. 99. Type: by original designation: *Pleurotoma circinata* Dall, 1873.  
1908 *Irenosyrinx* Dall, Bulletin Museum of Comparative Zoology, vol. 43, no. 6, p. 257. Type: by original designation: *Pleurotoma (Irenosyrinx) goodei* Dall, 1889.

**Aforia circinata (Dall, 1873)**

(Pl. 322, figs. 1-4; Pl. 323)

*Range*—Aleutian Islands and Bering Sea, south to Japan, Recent and Pliocene, in from 73 to 614 fathoms, and associated with a bottom temperature range of between 30.9°F. to 38.1°F.

*Remarks*—The writer follows Habe (1958, l.c.) in the compilation of the above synonymy. Habe wrote—“By Dr. Bartsch many species have been described from the Japanese seas, but they may be only local forms of *Aforia circinata*, with a complete intergradation among them. Therefore, they certainly have no specific value”. Kira (1962, l.c.), on the other hand used one of Bartsch's new names, *diomedea*, as a subspecies of *circinata* for the Japanese forms.

Judged from the type specimens alone, *circinata* would appear to differ from *diomedea* in having more numerous spiral cords from the carina to the lower suture, but when a range of specimens is examined this character breaks down, for there is a strong tendency towards the division of some of the primary cords into several weaker ones.

The radular evidence, also, is inconclusive since only two mounts are available, one attributed to *circinata* and the other to *okhotskensis*. Certainly the shape of the base of the central tooth differs markedly in these two mounts but more material is essential to determine if more than one species is represented by these variations. Another radular mount, that of *japonica* Bartsch, 1945, has a most distinctive central tooth, with a broad rectangular base, the lateral edges of which are strongly incurved. The shell of *japonica*, however, is sufficiently outside the range of variation judged to be admissible for *circinata* to allow Bartsch's shell specific status.

Another of Bartsch's species, *chosenensis* (1945), which was not included in Habe's (1958) synonymy for *circinata* appears to be only an immature example of that species, and is accordingly added to the synonymy.

Taking into account the great amount of variation in size, the strength of both the peripheral carina, and the surface sculpture, in Recent series of *circinata*, I hesitate to continue separate status for the following two Japanese Pliocene forms: *Pleurotoma (Surcula) nojimensis* Yokoyama and *Leucosyrinx (Aforia) circinata minatoensis* Otuka.

*Description*—Shell large, of light build, 70-92 mm.  $2\frac{3}{4}$ - $3\frac{5}{8}$  inches) in height, elongate-

fusiform, with a tall carinated spire and a rather long body-whorl, gradually tapered to a slightly flexed long anterior canal. Protoconch eroded in all material examined. Post-nuclear sculpture consisting of a medially situated strong narrowly rounded smooth peripheral carina, which upon erosion appears as a pair of closely spaced sharp cords. Above the carina the shoulder slope is smooth and glossy, except for sinus growth curves, and below it there are from 7-12 flat-topped spiral cords, separated by linear interspaces. There are from 25-40 similar spiral cords from the peripheral carina to the end of the anterior canal. The great variation in the number of spiral cords is on account of their variability in size due to the haphazard division of some cords into several smaller ones. The sinus is deep, the narrow U-shaped apex situated at about the lower third of the shoulder slope. Colour pale yellowish-buff to light horny-brown, covered by a thin greyish-buff periostracum. The operculum is horny, elongately ovate, commencing with a terminal ovate nucleus, its axis oblique and inclined inward, from which the subsequent growth is excentric, enlarging progressively more rapidly on the outer side. The radula consists of a unicuspid wide-based crescentic central tooth, no laterals, and a massive marginal with a superimposed much smaller long narrow accessory plate, that probably originated from the distal limb of a “wishbone-type” marginal. In another specimen (= *okhotskensis*) the unicuspid central tooth has a rectangular base that is slightly deeper than it is wide.

*Measurements (mm.)—*

height	width	
92.0	30.6	holotype; Unalaska
87.5	28.5	Okinawa
71.5	24.0	Japan, off Tyosi, 200 fathoms

*Synonymy—*

- 1873 *Pleurotoma circinata* Dall, Proc. Calif. Acad. Sci. vol. 5, p. 61, pl. 2, fig. 5.  
 1883 *Pleurotoma insignis* Jeffreys, Ann. Mag. Nat. Hist., p. 119.  
 1920 *Pleurotoma (Surcula) nojimensis* Yokoyama, Jour. Coll. Sci. Imp. Univ. Tokyo, vol. 39, p. 42, pl. 1, fig. 19.  
 1925 *Turricula (Surcula) hondoana* Dall, Proc. USNM, vol. 66, p. 29, pl. 31, fig. 6.  
 1945 *Aforia diomedea* Bartsch, Journ. Wash. Acad. Sci., vol. 35, no. 12, p. 389, pl., figs. 7, 8.  
 1945 *Aforia okhotskensis* Bartsch, Journ. Wash. Acad. Sci., vol. 35, no. 12, p. 391, pl., figs. 1, 2.  
 1945 *Aforia sakhalinensis* Bartsch, Journ. Wash. Acad. Sci., vol. 35, no. 12, p. 392, pl., figs. 3, 4.  
 1945 *Aforia chosenensis* Bartsch, Journ. Wash. Acad. Sci., vol. 35, no. 12, p. 392, pl., figs. 9, 10.



- 1949 *Leucosyrinx* (*Aforia*) *circinata minatoensis* Otuka, Jap. Journ. Geol. & Geogr., vol. 21, p. 305, pl. 13, fig. 11.  
 1958 *Aforia circinata* (Dall); Habe, Publ. Akkeshi Mar. Biol. Sta., no. 8, p. 29.  
 1958 *Leucosyrinx* (*Aforia*) *otohime* Ozaki, Bull. Nat. Sci. Mus., vol. 4, no. 1, pl. 16, figs. 2, 3. (Tyosi City, Iioka Formation, Pliocene, Japan).  
 1962 *Aforia circinata diomedea* Bartsch; Kira, Shells of the Western Pacific in Colour, p. 102, pl. 36, fig. 14.

**Types**—The holotypes of *chosenensis*, *diomedea*, *hondoana*, *okhotskensis* and *sakhalinensis* are in the United States National Museum, Washington.

**Records**—Recent: BERING SEA: "Icy Sea of Siberia" (*insignis*). ALEUTIAN ISLANDS: Nateekin Bay, Captain's Bay, Unalaska, east shore (*circinata*) (type locality). SAKHALIN ISLAND: near Cape Patience, Okhotsk Sea, 73 fathoms, bottom temperature 30.9°F., substratum green mud, sand and pebbles (Albatross Sta. 5005; USNM 205042) (*okhotskensis*); off Kinka San Light, 399 fathoms, bottom temperature 38.1°F., substratum dark sand with broken shell and foraminifera (Albatross Sta. 5051; USNM573613) (*sakhalinensis*); JAPAN, Sagami Bay, off Hondo, 614 fathoms, bottom temperature 37.5°F., substratum mud (Albatross Sta. 5087; USNM111052) (*hondoana*); off Yerimo Zaki, southeast Hokkaido, 309 fathoms, bottom temperature 32.1°F., substratum grey sand, coral and sand (Albatross Sta. 5044; USNM205039) (*diomedea*); same locality, 359 fathoms, bottom temperature 38°F., substratum brown mud with fine broken shell and coral sand (Albatross Sta. 5045; USNM 205040); Rikuzen, northeast of Honshu (Hirase coll., USNM 342737); off Tyosi, 200 fathoms (ex T. Shikama; Powell coll., Auck. Mus.); Kesennuma (ex D. Thaanum; Powell coll., Auck. Mus.); off Kushiro, Akkeshi Bay (Habe, 1958). KOREA: off Cape Clonard, southeast coast of "Chosen", 122 fathoms, bottom temperature 34.1°F., substratum grey mud (Albatross Sta. 4860; USNM205043) (*chosenensis*); RYUKYU ISLANDS: Okinawa (ANSP. 241766).

Pliocene:—JAPAN: Tomiya (*circinata minatoensis*).

### *Aforia japonica* Bartsch, 1945

**Range**—Off Honshu Island, Japan, from 302–369 fathoms.

**Remarks**—Bartsch made an unaccountable series of errors in introducing this species by crediting it in the synonymy to Dall, i.e. "1925 *Turricula japonica* Dall, Proc. U. S. Nat. Mus. 66: 29, pl. 26, fig. 11".

At that reference the species described by Dall is not an *Aforia*, but a trochoid, *Turricula japonica* new species; the plate reference is 36 not 26, and neither the locality cited, nor the station number, the measurements, or the holotype number, coincide with those for the *Aforia japonica* of Bartsch, so that the latter species becomes a new proposition; i.e. Bartsch, 1945, and the reference to Dall, 1925 must be deleted.

The writer has not seen the type of *japonica*

but from the description and figures it would appear to be outside the acceptable range of variation for *circinata*. The distinctive features of *japonica* are the smooth spire whorls, the low position of the peripheral carina, and the exceedingly fine and numerous spiral incised lines on the base and upper part of the anterior canal.

**Description**—Shell of medium size, 53 mm. (2 1/8 inches) in height, elongate-fusiform, with a tall spire, carinated below middle-whorl height, and a long slender very slightly flexed anterior canal. The spire whorls are smooth except for the last whorl, which is sculptured with exceedingly fine and very numerous feebly incised spiral lines, about 24 on the base and more than 50 on the neck, but over the anterior fourth of the anterior canal they disappear entirely.

#### Measurements (mm.)—

height	width	
53.0	18.1	holotype

#### Synonymy—

- 1945 *Aforia japonica* (Dall), Bartsch, Journ. Washington Acad. Sci. vol. 35, no. 12, p. 388, pl., figs. 5, 6 (non "*Turricula* (= *Turricula*) *japonica* Dall, 1925").

**Types**—The holotype (USNM205041) is in the United States National Museum, Washington.

**Records**—JAPAN: off Joka Sima Light, Sagami Bay, Honshu, 369 fathoms, bottom temperature 41.8°F., substratum green mud (Albatross Sta. 5088; USNM205041) (holotype); also same locality, 302 fathoms, bottom temperature 43.9°F., substratum black sand and broken shell (Albatross Sta. 5093; USNM205038).



Plate 323. *Aforia circinata* (Dall, 1873). Fig. 1, *Leucosyrinx circinata minatoensis* Otuka, 1949. Figs. 2, 3, type of *Leucosyrinx otohime* Ozaki, 1958. (all from Ozaki, 1958, pl. 16, figs. 1-3).

### Genus *Steiraxis* Dall, 1895

Type: *Steiraxis aulacus* Dall, 1895

This genus differs from *Aforia* in the lack of a shoulder sulcus, and in consequence, there is an overall sculpture of strong smooth spiral cords. (pl. 322 fig. 5). The posterior sinus is much shallower, and the radula has only a vestige of a central tooth. (Plate 324, fig. F.)

The genus has no representative in the Indo-Pacific, and is known only from off Acapulco, West Mexico in 1879 fathoms and the Gulf of Panama in 1772 fathoms.

#### *Synonymy*—

1895 *Steiraxis* Dall, Proceedings of the United States National Museum, vol. 18, p. 14. Type: by original designation: *Pleurotoma (Steiraxis) aulaca* Dall, 1895.

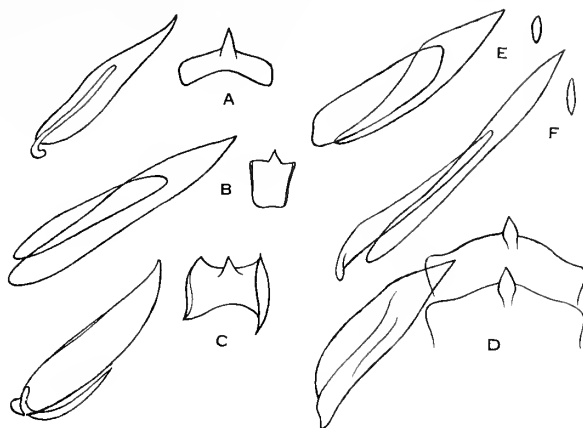


Plate 324. Radulae in *Aforia* and *Steiraxis*: A, *Aforia circinata* (Dall). Off Alaska. B, *Aforia circinata* (= *okhotskensis* Bartsch). Okhotsk Sea. C, *Aforia japonica* Bartsch. 369 fathoms, Honshu, Japan. D, *Aforia magnifica* (Strebel). 500 metres, Palmer Archipelago, Antarctica. E, *Aforia goodei persimilis* (Dall). 677 fathoms off Chile. F, *Steiraxis aulaca* (Dall). 1879 fathoms off Acapulco, Mexico.

*Published by*  
THE DEPARTMENT OF MOLLUSKS  
*Delaware Museum of Natural History*  
*Greenville, Delaware*  
*19807, U.S.A.*





